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2.2 AIR INDICATORS

TABLE

2.2 AIR INDICATORS[1]

2.2.1 EXECUTIVE SUMMARY

Four peer reviewers critically reviewed draft air indicators that EPA proposed to include in the ROE Technical Document. Four of these indicators were also reviewed by the ecological condition review group, and one indicator was also reviewed by the human health group.

Table 2.2-1, at the end of this section, summarizes the reviewers' overall recommendations of the proposed indicators. The air reviewers emphasized that their suggested revisions are all important for EPA's consideration, even though some are labeled in Table 2.2-1 as "suggested modifications." These reviewers also divided their suggested modifications into two categories, major and minor, as detailed in the tables showing the reviewer consensus statements.

The rest of this executive summary, along with Section 2.2.5, lists overarching comments and general themes from the air reviewers that apply to multiple indicators; Sections 2.2.2 through 2.2.5 describe the reviewers' specific comments on individual indicators.

When the ecological condition reviewers reviewed an indicator, they ranked it in terms of its importance in answering the question it was proposed to answer. When ranking an indicator, the reviewers considered the indicator as it would be when revised according to the "critical" modifications they listed in the "Consensus" table. These rankings appear in the upper right-hand corner of each "Consensus" table prepared by the ecological condition reviewers. A "High" ranking represents the most important indicators. In cases where the ecological condition reviewers recommended not including an indicator, they did not assign a rank, and these indicators are labeled NA.

One stakeholder, the Battery Council International, made an oral comment on the third day of the meeting. This comment pertained to two indicators: Lead Emissions and Ambient Lead Concentrations. The comment is included as Section 2.2.6 of this report.

2.2.1.1 General Issues for All Emissions Indicators

The peer reviewers agreed that the draft indicator text overstates the quality and confidence in emission inventories. They recommended that the indicator text be revised to discuss the relative confidence in the inventories for individual pollutants (e.g., much higher confidence in emissions data for sulfur dioxide and nitrogen oxides, much lower confidence in emissions data for air toxics, mercury, and volatile organic compounds [VOCs]).

Emissions data back to 1980 should be included to allow for better interpretation of ambient air concentrations, except when older data are of insufficient quality. These older data are already available from existing EPA documents. In cases where older data are not of sufficient quality (e.g., mercury), only current data should be presented to establish baseline levels for future trend analyses.

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[1] At the time of this peer review, EPA intended to publish the ROE Technical Document in 2006. Therefore, this summary of reviewer discussions refers to the "2006 Report on the Environment" and "ROE06." These terms are synonymous with all references to the "2007 Report on the Environment" and "ROE07" elsewhere in this report.

The indicators should document contributions from all sources, not just the anthropogenic ones. Contributions from natural sources (e.g., biogenic sources) can be addressed, whether with a pie chart indicating the breakdown of emissions for the current year or by including additional text. Natural sources should not be included in the trend plots.

Emissions trends for pollutants that had significant changes to inventory methodologies can be misleading (e.g., PM with and without "condensables"). For trend analysis, presenting emissions data from a consistently applied methodology, even if not the best methodology, is preferred to presenting data from multiple methodologies applied differently over the years.

Several indicators provide emissions data on groups of compounds (e.g., VOCs, air toxics, and greenhouse gases). EPA should not simply report total mass of compounds emitted within such groups, but rather display data weighted to the issue of concern. For instance, VOCs can be reported as reactivity-weighted emissions to better inform ozone formation potential, and air toxics can be reported as toxicity-weighted emissions to relate to the potential for causing human health effects. Additionally, where possible and appropriate, data on individual compounds should be presented (e.g., show trends for the air toxics believed to account for the largest proportion of cancer risk and non-cancer hazard). This information is already available from existing EPA documents.

Comments that apply to all figures:

- Include equal spacing between all years shown in graphs.
- Use more transparent terminology when referring to source categories. For instance, use "electrical utilities" instead of "Title IV facilities"; do not use overlapping terms such as "fuel combustion" separate from "mobile sources," but instead use "fuel combustion from stationary sources" and "fuel combustion from mobile sources." Use the same terminology across all inventory components, to the extent possible.
- Present data back to 1980, as appropriate to cover a time period long enough to show meaningful trends.
- Regional figures would benefit from showing source categories, which can be done using maps with pie charts or stacked bar charts instead of the current line charts.
- Use same formats and styles on all emissions figures.

2.2.1.2 General Issues for All Ambient Concentration Indicators

EPA should discuss uncertainties associated with the trends that are reported. In cases where the available data do not span enough years to infer trends (e.g., PM2.5 concentrations), the indicators should not present trend statistics but should explain why future data collection is needed to support trend analyses.

Statistical analysis:

- Do not use percent changes between two endpoints when quantifying long-term trends.
- Multiple suggestions were provided for different approaches (e.g., compare 3-year averages at endpoints; use regression analyses, non-parametric trend analyses [e.g., Kendall's Tau], or other statistical analyses or tests) for quantifying the trends.
- Use statistical tests to characterize confidence in quantitative estimates of long-term trends.

Comments that apply to all figures:

- All figures, to the extent possible, should be presented in a common format. The format currently used for most indicators is a distribution plot for displaying nationwide trends and line charts for displaying regional trends.
- Display median values (not means) on plots that show percentiles (e.g., the national trend figure for PM10 in Figure 003-1).
- For each criteria pollutant, superimpose on each plot annual trends in the number of stations with concentrations that exceeded the corresponding NAAQS.
- Text beneath figure should indicate the percent change for only the entire time frame considered, not for multiple time frames.
- On regional maps, have each individual time series drawn to the same scale, with a horizontal line drawn at the corresponding NAAQS.

2.2.1.3 Regional Indicators

The reviewers supported EPA's desire to include regional indicators, but strongly recommended that EPA not include the two proposed regional indicators in ROE06: both indicators have serious technical problems, are potentially misleading, and make no important contribution to answering the overarching questions about ambient air quality, even on a regional scale. The reviewers suggested that all regional indicators included be placed in a national context. The body of this peer review summary report includes additional suggestions for EPA to consider when selecting regional indicators in the future.

2.2.1.4 Indicators That Address Issues of a Global Scale

These indicators should, when possible, provide some insight on the contribution that the United States makes compared with worldwide totals.

2.2.1.5 General Issues for All Indicators

Some information on the "metadata" forms was copied into multiple indicators, sometimes inappropriately so. The information on the "metadata" forms should be more informative and specific to the individual indicators. More indicator-specific information should be presented on the estimation approaches, sampling and analytical methods, and so on.

Indicator text would benefit from issue-specific contextual discussion, similar to interpretations presented in annual reports and other documents published by EPA's Office of Air and Radiation (OAR) and Office of Air Quality Planning and Standards (OAQPS). EPA should use graphics from these reports in the ROE indicators, to the extent practical.

For several indicators, the data presented do not completely characterize the issue being discussed. For instance, the greenhouse gas emission indicator does not include data on the contributions of chlorofluorocarbons (CFCs), the indicator on mercury deposition does not present information on dry deposition, and several emissions indicators do not include data on contributions of natural sources. In such cases, the text should describe—quantitatively, where possible—the significance of omitting certain aspects of the indicator.

Many indicators do not present data for the entire time period over which data are available. Indicators should present the entire set of data, including older data and more recent data, unless there are strong reasons for not doing so.

Regarding the three indicators that EPA proposed withdrawing from the Air Chapter, the peer reviewers disagreed with EPA's proposal to withdraw the indicator on the number of people living in counties with ambient air concentrations above National Ambient Air Quality Standards (NAAQS), and they disagreed with EPA's proposal to withdraw the indicator on production of ozone-depleting substances. The reviewers agreed with EPA's decision to withdraw the indicator on the percent of population living in homes where someone smokes regularly, though for reasons other than what EPA provided. As described below, EPA should consider using an alternate indicator that provides an objective measure of trends in smoking behavior to complement the indicator on blood cotinine levels.

The peer reviewers recommended that EPA add three indicators to ROE06: (1) sea level rise and sea surface temperature (for further context on climate change); (2) tobacco use, as inferred from tobacco sales or tobacco taxes (for further context on indoor air quality); and (3) concentrations of nitrogen dioxide (for further context on criteria pollutants).

This summary report documents the main comments that the reviewers made during the meeting. EPA should refer to the peer reviewers' pre-meeting comments for additional feedback on the individual indicators.

Table 2.2-1. Peer Reviewer Recommendation Tracking Table for Air Indicators

Indicator	Include with Suggested Modifications	Don't Include Unless Critical Modifications Are Made	Don't Include
Outdoor Air: Emissions Indicators			
PM emissions		✔	
SO_2 emissions	✔		
NO_x emissions	✔		
VOC emissions	✔		
Lead emissions	✔		
Air toxics emissions		✔	
CO emissions	✔		
Mercury emissions		✔	
Outdoor Air: Ambient Concentration Indicators			
Ambient PM concentrations	✔		
Ambient ozone concentrations	✔		
Ambient lead concentrations	✔		
Ambient concentration of a selected air toxic: benzene		✔	
Ambient CO concentrations	✔		
Number and percent of days AQI values >100		✔	
Ambient concentrations of manganese metal compounds			✔
Ozone and PM for the U.S./Mexico border counties			✔
Outdoor Air: Other Indicators			
Ozone levels over North America	✔		
Concentrations of ozone-depleting substances		✔	
Atmospheric deposition of mercury	✔ (ecological group)		✔ (air group)
Acid deposition	✔		
Visibility	✔		
Ozone injury to forest plants	✔		
Greenhouse Gases			
U.S. greenhouse gas emissions	✔		
Atmospheric concentrations of greenhouse gases	✔		
Indoor Air			
U.S. homes above EPA's radon action level	✔		
Blood cotinine	✔		

Note: The reviewers unanimously agreed that all indicators in the first two columns are important. They explained that the indicators listed in the column titled "don't include, unless critical modifications are made" are currently very misleading or simply incorrect. Therefore the reviewers felt strongly that, unless the changes outlined in the body of this report are addressed, these indicators should not be included in ROE06. The peer reviewers explained that "suggested modifications" are changes that the reviewers felt would significantly improve the indicator; however, EPA should still keep the indicator in ROE06 even if it decides not to make the change. "Suggested modifications" should not be viewed as entirely optional.

2.2.2 OUTDOOR AIR QUALITY

2.2.2.1 PM Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include, unless critical modifications are made.**
Critical modifications	• Starting in 1999, PM emissions were estimated using a different methodology. The indicator implies that a considerable increase in emissions occurred that year, which is entirely an artifact of the new emissions estimation methodology. The reviewers emphasized that statements in the text and the figure must be modified to better reflect actual data trends and not these artifacts. The text beneath this table presents the reviewers' specific suggestions on this matter. • The reviewers agreed that it is acceptable for the figures to present data only on emissions source categories of anthropogenic origin. However, they found it unacceptable for the indicator text to not identify non-anthropogenic sources (e.g., wildfires, prescribed burns, geological dust) and their estimated particulate emission levels. The reviewers recommended that a pie chart be added to the indicator to illustrate the breakdown of all PM emissions in the inventory for the current year only. Showing trends in the emissions of non-anthropogenic origin was not considered important, given that these typically do not change dramatically with time. • The indicator text should identify any known sources of PM emissions that are not included, regardless of the reason. The peer reviewers noted that is not clear, for example, if diesel exhaust particulate is included in the PM emissions data.
Suggested modifications	• EPA should make the suggested revisions identified in the Executive Summary under "General Issues for All Emissions Indicators." To make these changes, EPA should draw from data already presented in other OAR publications (e.g., the 2004 *Particle Pollution Report*, EPA 454-R-04-002). EPA should also specifically consider the "General Issues for All Indicators." • EPA should revise the figure depicting regional trends, considering the suggestions listed at the end of this table.
Other comments	• Several minor revisions were noted during the discussions and are documented at the end of the text below.

The peer reviewers unanimously agreed that the PM emissions indicator provides important insights on the overarching question on ambient air quality. Accordingly, the reviewers strongly supported including this indicator in ROE06, provided that EPA first clarifies the potentially misleading aspects in the text and figures. The table above identifies critical modifications and additional important revisions. More detailed information on the reviewers' recommendations follows:

- **Changes in emissions estimation methodology.** Every reviewer found the text and graphic to provide a misleading account of trends in PM emissions, due largely to the significant change in estimation methodology that occurred between the 1998 and 1999 inventories. The reviewers noted that the following indicator text was particularly problematic: "…total PM10 emissions…decreased by 6 percent between 1990 and 2002" and "total PM2.5 emissions…increased by 4 percent between 1990 and 2002." These reported changes do not reflect actual trends, because they are confounded by the change in estimation methodology. EPA should revise these statements to document trends using a consistent methodology.

  Similarly, the reviewers said Figures 008b-1 and 008b-2 must be modified to avoid implying an emissions increase in the year when a new estimation methodology was implemented. Several suggestions were offered to improve these figures: (1) If sufficient data are available, include condensable emissions for all inventory years, not just for 1999 to 2002; (2) If the first suggestion is not feasible, present emissions data for the entire period of record without including contributions from condensable particulate; or (3) Include two separate plots for both PM10 and PM2.5, one showing the trend in PM emissions without the condensable portion (e.g., for 1990 to 2002) and the other showing only the condensable data (e.g., for 1999 to 2002). Any of these approaches were considered acceptable, provided that the current graphs are not displayed in ROE06.

- **Figures 008b-3 and 008b-4.** The peer reviewers did not find the regional figures particularly useful because it is difficult to identify the different EPA regions on the plot and because some "trends" depicted in the figure likely represent changes in estimation methodologies (e.g., the increases shown between 1998 and 1999). The reviewers suggested that EPA replace these figures with maps that show either (1) trends in emissions across multiple years or (2) pie charts that illustrate the regional breakdown of PM emissions among source categories for the most recent inventory year available.

- **Additional comments.** The peer reviewers made several additional recommendations they considered important, but not as critical as those listed above. One suggestion was to explain that PM is a complex mixture of multiple constituents, with compositions that vary from one location to the next—an issue the reviewers revisited when discussing PM concentrations. Another suggestion was to more prominently acknowledge that secondary particles are not included in this inventory and to provide some context on how much airborne PM2.5 results from secondary particle formation, as opposed to primary emissions. The reviewers also suggested revisions to the "metadata" form (see pre-meeting comments submitted by Drs. Fairley and Hidy) and editorial revisions (see pre-meeting comments submitted by Dr. Fairley).

2.2.2.2 SO_2 Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators" and under "General Issues for All Indicators."
Other comments	• The indicator write-up should include additional context explaining why SO_2 emissions are important. For instance, the text should note that relatively few people live in areas where SO_2 concentrations exceed the National Ambient Air Quality Standards, but a much larger number of people live in PM2.5 non-attainment areas—an issue directly affected by SO_2 emissions.

The reviewers unanimously agreed that trends in SO_2 emissions are important considerations for evaluating multiple environmental issues and therefore recommended that EPA include this indicator in ROE06. The indicator should be revised by considering all of the general suggestions listed in the Executive Summary of this section. Examples of reviewers' specific comments at the meeting include:

- **Confidence in the emissions inventory.** The reviewers agreed that the emissions indicators should discuss the relative confidence in the inventories for individual pollutants. In the case of SO_2 emissions, the reviewers noted that a large portion of the emissions data are directly measured, not estimated. Accordingly, they rated their confidence in the inventory for this pollutant as an "A" (on an A to F scale). The reviewers recommended that the indicator write-up give a better sense of the high level of confidence in the SO_2 inventory.
- **Figures.** The peer reviewers recommended that EPA consider their general suggestions provided for all emissions indicators (see Executive Summary). For instance, one reviewer noted that graphs in other OAR documents depict SO_2 emissions trends dating back to 1980. Additionally, several reviewers suggested that EPA identify the source categories using terminology that is more familiar to readers (e.g., avoid using terms like "Fuel Combustion, Title IV"). Finally, some reviewers did not find Figure 008d-2 particularly informative without providing insights on contributions from different source categories. Suggested improvements included either including a map showing regional long-term trends by source categories with stacked bar charts or a map showing regional emissions for the current year only using pie charts.
- **"Metadata" forms.** Several reviewers noted that information presented on the "metadata" form for this indicator was sometimes not specific to SO_2. Some text in the form, for example, applies to hazardous air pollutants. The reviewers recommended that EPA update the form to be more specific to SO_2, and update the forms for other indicators accordingly.

2.2.2.3 NO_x Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators" and under "General Issues for All Indicators."
Other comments	• The indicator text should clarify that the data presented are for anthropogenic sources only and should provide some quantitative context on NO_x emissions from biogenic sources.

The peer reviewers unanimously agreed that the indicator is appropriate, adequate, and useful for evaluating air quality and provides an important contribution to ROE. The reviewers classified their comments, listed below, as being minor:

- **Biogenic sources.** The indicator does not clearly state that the emissions data presented are only for anthropogenic sources. The reviewers recommended that the indicator clearly explain which types of sources are included in the figures and quantify the significance of omitting biogenic sources. Given that biogenic emissions are expected to remain relatively constant from one year to the next, the reviewers supported the approach of limiting the trends data to emissions of anthropogenic origin.
- **Confidence in the emissions inventory.** The reviewers agreed that the emissions indicators should discuss the relative confidence in the inventories for individual pollutants. In the case of NO_x emissions, the reviewers noted that the inventory includes a combination of measured emissions and estimated emissions. They rated their confidence in the inventory for this pollutant as a "B" (on an A to F scale). For further insights on potential limitations of the NO_x emissions inventory, one reviewer recommended that EPA refer to a recent NARSTO publication titled *Improving Emissions Inventories for Effective Air Quality Management Across North America* (available online at: http://www.cgenv.com/narsto).
- **Figures.** The reviewers suggested several improvements to the figures. For instance, the reviewers did not find the proposed figure of regional trends (Figure 008a-2) to be particularly informative and questioned the significance of changes in emissions observed between one year and the next. They recommended that EPA not include the figure in ROE and replace it instead with a map. Such a map could show, for EPA region, the overall trend in emissions between 1990 and 2002 (e.g., using an upward or downward arrow and percentage change) and a pie chart showing the breakdown of NO_x emissions by source category within each region.

Additionally, the peer reviewers recommended that EPA consider their general suggestions provided for all emissions indicators (see Executive Summary): one reviewer noted that graphs in other OAR documents depict NO_x emissions trends dating back to 1980; several reviewers suggested that EPA identify the source categories using terminology that is more familiar to readers (e.g., avoid using terms like "Fuel Combustion, Title IV"); and reviewers recommended that EPA revise the graph to include equal spacing in the years shown along the x-axis.

2.2.2.4 VOC Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Suggested modifications	• Compared to the inventories for other pollutants (e.g., sulfur dioxide, nitrogen oxides), the emissions inventory for VOCs is based much more so on estimates rather than direct measurements. The indicator should more prominently acknowledge the greater uncertainty that results from these estimates. • Lumping emissions of all VOCs into a single number obscures potentially important trends in photochemical reactivity or for individual VOCs or sub-groups of VOCs. The revised indicator should track reactivity-weighted emissions or emissions data for selected VOCs or groups of VOCs. • The reviewers found it appropriate to exclude biogenic emissions from the trend figures, but they recommended that the indicator text include an estimate of the total VOC emissions from biogenic sources. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators" and under "General Issues for All Indicators."
Other comments	• The indicator should clearly describe what chemicals are included in total VOCs, as some reviewers questioned whether the indicator tracked certain organic compounds, most notably methane.

The reviewers unanimously agreed that VOC emissions are important to track because airborne VOCs contribute to photochemical reactions that form ozone. They found the indicator could provide appropriate, adequate, and useful information on air quality, but major revisions are needed to the indicator text and figure to ensure that this information is not misleading:

- **Additional ways to present data.** The indicator tracks total VOCs, a composite of dozens of pollutants with differing photochemical reactivity. Tracking emissions of total VOCs might mask significant trends in the most reactive species. Accordingly, the reviewers recommended that this indicator include additional graphics to provide improved insights on VOC emissions. Specific suggestions included presenting trends in reactivity-weighted total VOC emissions, tracking emissions for selected VOCs (e.g., the most abundant species, the species believed to contribute most to ozone formation), or tracking emissions for important sub-groups of VOCs (e.g., paraffins, olefins, and aromatic hydrocarbons). Reviewers noted that EPA might be able to generate estimates of reactivity-weighted emissions by drawing from speciated emissions data, to the extent these are available.
- **Confidence in the emissions inventory.** The reviewers noted that the emissions inventory for VOCs is based largely on estimates, rather than direct measurements. For instance, a large portion of VOC emissions comes from fugitive sources, whose emissions are tracked primarily by estimation methodologies. As a result, the reviewers noted that the VOC emissions inventory has considerably greater uncertainty than does the inventories for other pollutants, and they rated their confidence in the VOC inventory as a "C-" or a "D" (on an A to F scale). The reviewers recommended that the indicator text more explicitly describe the greater uncertainty associated with this inventory, perhaps

by specifying the portion of the total emissions that are based on estimates rather than direct measurements.

- **Biogenic sources.** The draft indicator text notes that emissions data are presented for "anthropogenic sources, excluding wildfires and prescribed burnings." The reviewers found it appropriate to omit biogenic sources from the trend figures, given that these emissions are not expected to change dramatically over the long term. However, the reviewers recommended that the indicator text include quantitative information on biogenic sources to give the reader some context on their potential significance.
- **Other comments.** The reviewers recommended that EPA revise the figures in this indicator based on the recommendations listed in the Executive Summary under "General Issues for All Emissions Indicators" and "General Issues for All Indicators." Additionally, some reviewers questioned trends shown in Figure 008e-2. For instance, one reviewer wondered if total VOC emissions in Region 10 truly increased considerably between 1998 and 1999 or if this apparent increase actually resulted from use of different estimation methodologies. The reviewers recommended that EPA consider replacing Figure 008e-2 with a map that presents more meaningful data for each region. One suggestion was to include a pie chart for each region that shows the breakdown of total VOC emissions by source category for 2002 only, along with a downward or upward arrow depicting the decrease or increase in total VOC emissions over the time frame of interest (1990 to 2002).

2.2.2.5 Lead Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• By not presenting data on the very significant decrease in lead emissions that occurred in the 1970s and 1980s, Figure 009-1 is very misleading and should be revised to track emissions over a longer time frame. The figure should also present emissions data broken down by source categories to illustrate that the emissions reductions resulted largely from phasing out leaded gasoline. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators" and under "General Issues for All Indicators."
Other comments	• Based on insights provided during the public comment period, the reviewers recommended that EPA verify whether the following statement in the indicator is correct: "The highest air concentrations of lead are usually found in the vicinity of smelters and battery manufacturers."

The reviewers agreed that ROE06 should include an indicator on lead emissions, because lead exposure is an important environmental issue, even if current exposures are not primarily through inhaling ambient air. The reviewers recommended that EPA revise the proposed indicator in the following ways:

- **Figure 009-1.** The reviewers agreed that Figure 009-1, by excluding data from the 1970s and 1980s and by not depicting contributions of different source categories, fails to tell the entire story of how

lead emissions have changed in the United States. They recommended that EPA revise the figure to depict a more meaningful trend in lead emissions (e.g., see the figure on page 1-30 of the pre-meeting comment booklet). By presenting data back to the 1970s, the lead emissions trends would provide better context for interpreting the trends shown in the indicator on ambient air concentrations of lead.

- **Confidence in the emissions inventory.** The reviewers noted that the emissions inventory for lead is based largely on estimates, rather than direct measurements, but the indicator provides no information on the overall confidence in the inventory estimates and the associated uncertainties. The reviewers rated their confidence in the lead inventory as a "B" (on an A to F scale) and recommended that the indicator text more explicitly describe the uncertainty associated with this inventory.
- **Other comments.** After hearing an observer comment provided on behalf of Battery Council International, the reviewers recommended that EPA verify the accuracy of the statement in the indicator text regarding battery manufacturers. Additionally, one reviewer questioned whether the current emissions data include contributions from road dust.

2.2.2.6 Air Toxics Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include, unless critical modifications are made.**
Critical modifications	• Lumping emissions of all air toxics into a single number (i.e., emissions of all air toxics combined) is somewhat meaningless because that number obscures potentially important trends in individual air toxics. Emissions trends for total air toxics will likely be dominated by the chemicals with greatest emissions, not necessarily those of greatest concern from a health perspective. Accordingly, the reviewers recommended that EPA present emissions data for air toxics of particular interest or present toxicity-weighted emissions data, rather than present emissions data for total air toxics. The text beneath this table lists the reviewers' detailed recommendations to address this issue.
Suggested modifications	• EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators." To make these changes, EPA should draw from data already presented in other OAR publications (e.g., Strum et al. 2005). EPA should also specifically consider the "General Issues for All Indicators."
Other comments	• Several minor revisions were noted during the discussions and are documented at the end of the text below.

The peer reviewers unanimously agreed that the air toxics emissions indicator provides important insights on the overarching question on ambient air quality. Accordingly, the reviewers strongly supported including this indicator in ROE06, provided EPA addresses the critical modifications listed above and elaborated upon in the text below:

- **Alternate presentation format.** To address the limitations of presenting emissions data for all air toxics combined, the peer reviewers offered several suggestions for how the air toxics emissions indicator can be more informative. The reviewers' main suggestion was to present emissions data on a subset of air toxics. The chemicals could be selected in various ways, such as selecting the air toxics

that, according to the National Air Toxics Assessment (NATA), account for the largest portion of nationwide cancer risk or non-cancer hazards. For these chemicals, EPA could simply plot the percent increase or decrease in estimated emissions over the period of inventory record. The peer reviewers noted that EPA already has plots that present data in exactly this manner (Strum et al. 2005).

Though the reviewers strongly supported this alternate approach to presenting data, they also noted some limitations that the indicator will need to address. First, several reviewers commented that the emissions inventories for individual air toxics likely have considerable uncertainties, which must be acknowledged in the indicator text. If emissions data for a particular air toxic are believed to be unreliable, then these data should not be presented in the indicator. Second, the text should note that EPA has not developed health benchmarks (e.g., unit risk factors for cancer effects, reference concentrations for non-cancer effects) for many air toxics.

- **Other comments.** The reviewers recommended that the indicator text note additional assumptions inherent in the data. For instance, text should be added explaining that the emissions inventory data do not include estimates for every harmful substance that is released to the air (e.g., diesel exhaust particulate is not included). Further, the text should note that the emissions inventory does not consider secondary formation of pollutants, which can be significant for some air toxics, like acetaldehyde and formaldehyde.

Reference

M Strum, A Pope, T Palma, R Mason, S Shedd, R Cook, J Thurman, D Ensley. The Projection of Hazardous Air Pollutant Emissions to Future Years: Methods and Results. Presented at the 2005 Emission Inventory Conference, Las Vegas, Nevada. April 2005.

2.2.2.7 CO Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• By not presenting data on decreases in CO emissions that occurred prior to 1990, Figure 330-1 provides an incomplete account of emissions reductions that have occurred over the longer term. Presenting data for prior decades will also allow for more meaningful interpretation of the indicator on ambient concentrations of CO. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators" and under "General Issues for All Indicators."
Other comments	• Additional contextual information should be included in the indicator write-up on the confidence in the CO emissions inventory and on the fact that CO emissions continue to decrease over a time frame when vehicle miles traveled have increased.

The reviewers agreed that ROE06 should include an indicator on CO emissions, given that exposure to elevated CO concentrations has proven that health effects and air quality in some parts of the country still do not meet EPA's corresponding air quality standards. The reviewers recommended that EPA revise the proposed indicator as follows:

- **Confidence in the emissions inventory.** The reviewers agreed that the emissions indicators should discuss the relative confidence in the inventories for individual pollutants. For CO emissions, a major contributor to the overall inventory is emissions from mobile sources, which are estimated and not measured directly. One reviewer questioned the extent to which estimated emissions from mobile sources reflect actual emissions from driving vehicles. For further insights on limitations associated with the CO inventory, he referred EPA to a recent NARSTO publication titled *Improving Emissions Inventories for Effective Air Quality Management Across North America* (available online at: http://www.cgenv.com/narsto). The reviewers rated their overall confidence in the CO inventory as a "B" (on an A to F scale).
- **Figures 330-1 and 330-2.** The reviewers referred to their general comments on the emissions indicators for suggested revisions to Figures 330-1 and 330-2. Of particular importance, they recommended that Figure 330-1 present data for years prior to 1990 to allow for better interpretation of the ambient concentration data (which covers 1980 to the present). Additionally, several reviewers found the current presentation of regional data to be inadequate and recommended that EPA consider presenting regional emissions data on maps rather than graphs.
- **Other comments.** The reviewers recommended that the indicator write-up provide additional context on the emissions trends. Specifically, the text should acknowledge that, and explain why, CO emissions have decreased over a time frame when total vehicle miles traveled has increased.

2.2.2.8 Mercury Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include, unless critical modifications are made.**
Critical modifications	• After expressing serious concerns about the quality of the 1990 mercury emissions inventory data and their comparability to more recent data (see below for further details), the peer reviewers recommended that the indicator present emissions data only for 1999 and 2002. Trends should not be inferred from the data for these 2 years; rather, these data should be viewed as baseline emissions levels that can be examined in future trend analyses.
Suggested modifications	• Given that mercury issues are global in nature, the indicator text should include additional context on how anthropogenic emissions of mercury in the U.S. compare to (1) mercury emissions from natural sources and (2) mercury emissions worldwide. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators." EPA should also specifically consider the "General Issues for All Indicators."
Other comments	• Several minor revisions were noted during the discussions and are documented at the end of the text below.

The peer reviewers unanimously agreed that the mercury emissions indicator addresses an important environmental issue and is therefore appropriate to include in ROE06. However, the reviewers had serious reservations about the quality of the 1990 emissions data and recommended that EPA exclude these data from the indicator:

- **Concerns about the 1990 emissions data.** Several reviewers did not think the 1990 mercury emissions data are of sufficient quality and comparability to include in ROE06. One reviewer noted, for instance, that the 1990 data are taken from the National Emissions Inventory, while the 1999 data are taken from the National Toxics Inventory, which apparently uses different estimation methodologies. Accordingly, this reviewer wondered if the apparent decrease in emissions is explained by use of different estimation methodologies or by actual reductions. Echoing this concern, another reviewer noted that one source category (gold mining facilities) does not appear in the 1990 inventory at all, but is a fairly significant source category in the 1999 inventory. While reviewers acknowledged that the inventory might be fairly robust for source categories that have been studied extensively since 1990, such as municipal waste combustors and medical waste incinerators, they were far less confident in the accuracy of the emissions estimates for other source categories. Given these and other underlying concerns specific to the 1990 inventory, the peer reviewers recommended that, the mercury emissions indicator in ROE06 present data only for 1999 and 2002, which will serve as a baseline for future issues of ROE.
- **Global context.** The reviewers recommended that the indicator text place the estimated mercury emissions attributed to U.S. anthropogenic sources into a global context. For instance, the text should note how the U.S. emissions from anthropogenic sources compare to total worldwide releases from anthropogenic sources. Additionally, the text should describe how emissions from anthropogenic sources compare to emissions from natural sources (e.g., oceans, volcanoes). Information on these topics is likely available from existing EPA reports, like the *Mercury Study Report to Congress*.
- **Completeness of inventories.** The mercury emissions data, according to one reviewer, do not include contributions from all potential source categories, such as mobile sources and releases associated with disposal of fluorescent bulbs and mercury switches. He recommended that this be noted among the "indicator limitations." This comment applies to both the 1990 and 1999 inventories.
- **Other comments.** One reviewer recommended that the indicator text note that the emissions inventory tracks releases of total mercury, even though mercury is emitted in multiple chemical forms, including mercury vapor, mercury salts, and organic mercury compounds. Other peer reviewers wondered if Toxics Release Inventory (TRI) data might offer insights into annual emissions from selected source categories dating back to the 1980s. However, the reviewers identified potential problems associated with using TRI data, including uncertainties in facilities' self-reported emissions data and the fact that many facilities likely were not required to submit TRI reports for mercury in the 1980s and 1990s until EPA drastically lowered the mercury reporting thresholds in recent years.

2.2.2.9 Ambient PM Concentrations

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Suggested modifications	• Consistent with EPA's air quality standards, the indicator should present data for both annual average and 24-hour average concentrations of PM10 and PM2.5. • The indicator should include data collected by the IMPROVE air monitoring network or explain why those data are excluded. • Long-term trends in air quality should be based on more sophisticated statistical analysis and not simply on comparing concentrations at two endpoints in a time series. • The indicator should provide information on particle speciation, whether for recent years or for trends over the longer term. Speciation data are already summarized in other EPA documents (e.g., EPA 2004). • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators" and under "General Issues for All Indicators."
Other comments	• The "indicator limitations" should acknowledge potential biases associated with particulate sampling and analytical methods.

Although the reviewers unanimously agreed that trends in PM concentrations are appropriate, adequate, and useful for tracking changes in air quality and strongly recommended that this indicator be included in ROE06, they also found the indicator text and figures to be potentially misleading in several regards. The reviewers therefore recommended that this indicator remain in ROE, but with major revisions:

- **Averaging periods.** EPA has set PM air quality standards for two averaging periods: annual average concentrations and 24-hour average concentrations. However, the draft indicator presents data only for annual average concentrations. Peer reviewers recommended that data on 24-hour PM levels be included, given that some counties are classified as non-attainment areas due to violations of the 24-hour average standard and not the annual average standard. In particular, the estimated design values (the 98th percentile for PM2.5 and the 99th percentile for PM10) should be used.
- **Data sources.** When discussing the data sources used for this indicator, the reviewers learned that all sampling data from the IMPROVE network were excluded. The reviewers recommended that EPA either include data from this network in the revised indicator or explain why they are being excluded.
- **Statistical analysis.** The reviewers had serious reservations about approaches EPA took to characterize trends in PM monitoring data. For example, the draft PM10 indicator quantifies trends by comparing data collected in 1988 to those collected in 2003 (i.e., the two "endpoints" for the period of record). Such an approach, the reviewers argued, makes the trend estimates entirely dependent on just 2 years of data, which can be highly influenced by meteorological effects or other confounding factors. The reviewers recommended that EPA use more sophisticated statistical analyses when quantifying these trends (see "General Issues for All Ambient Concentration Indicators" for specific suggestions). As another example, the reviewers questioned whether 6 years of monitoring data are

sufficient to establish trends in PM2.5 concentrations. They recommended that ROE06 instead present the currently available PM2.5 data as an indication of "baseline" air concentrations and that trend analyses should be saved for future ROE releases, when monitoring data are available over a longer time frame.

- **Speciation.** The reviewers were concerned that the draft PM indicator presents virtually no information on particle speciation, which can provide useful insights on differences between PM10 and PM2.5 and the factors that contribute most to PM concentration trends. The reviewers agreed that speciation data are important to include in this indicator, even if the available data are only sufficient for establishing "baseline" conditions and not actual trends. The speciation data can be presented in various ways, possibly using pie charts to depict how particle composition varies across the country, as has already been done in EPA's *Particle Pollution Report* (EPA 2004, page 3).
- **Other comments.** The reviewers suggested numerous improvements to Figures 003-1 to 003-4. For both figures, they suggested that the graphs present both trends in ambient concentrations trends and in the number of stations that had measured concentrations greater than EPA's air quality standards. Additional comments on the figures are documented in the "General Issues for All Ambient Concentration Indicators." Additionally, reviewers recommended that EPA expand the "indicator limitations" section to acknowledge potential biases associated with PM sampling and analytical methods. Such biases might result from volatilization of nitrates from filter samples, condensation of material on filter samples, or evaporation of species containing organic carbon. The limitations should also acknowledge the lack of information to adequately address long-term trends in PM speciation.

Reference

EPA 2004. The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003. U.S. Environmental Protection Agency. EPA 454-R-04-002. December 2004.

2.2.2.10 Ambient Ozone Concentrations

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Suggested modifications	• Improved statistical analyses are needed to characterize long-term trends in ozone concentrations. Simply comparing data collected in 1980 to 2003 is an inappropriate method for quantifying trends. Several suggestions (see below) were provided for a more defensible and meaningful statistical analysis of the monitoring data. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators" and under "General Issues for All Indicators." • For consistency with EPA's air quality standards, the indicator should track the running fourth highest daily maximum 1-hour ozone value over 3 years, rather than the second maximum 1-hour ozone value for a single year.
Other comments	• The indicator write-up should provide additional contextual information on ozone formation processes and the role of meteorology, as described below under "other comments." • EPA should consider presenting separate data for rural monitoring stations, possibly drawing from data collected by the CASTNet monitoring stations.

Noting that ozone remains a challenging air quality issue and that millions of people live in areas that do not meet EPA's ozone air quality standards, the reviewers unanimously agreed that an indicator on ambient air concentrations of ozone is appropriate, adequate, and useful for tracking important changes in air quality. However, the reviewers concluded that the draft indicator requires major revisions:

- **Statistical analysis.** Given that ambient air concentrations of ozone are strongly dependent on local meteorological conditions, which can vary considerably from one year to the next, the reviewers recommended that EPA not quantify long-term trends in ozone concentrations simply by comparing data collected in just 2 years (e.g., 1980 versus 2003). As an example of their concern, the reviewers referred to the 8-hour ozone "trend" shown in Figure 004-4 for EPA Region 10. The figure reports a 17% increase in ozone concentrations, even though visual inspection of the data plotted suggests no discernible trend is apparent. The reviewers noted that the "increase" in 8-hour ozone levels for this region might simply be an artifact of ozone levels being unusually low or high in the endpoint years. The reviewers recommended that EPA use other statistical approaches to characterize long-term trends and associated uncertainties. One suggestion was to compare the average of the first 3 years of the time series with the average of the latest 3 years. Other suggestions are listed in the Executive Summary of this report, under "General Issues for All Ambient Concentration Indicators."

- **Indicator statistic.** For consistency with EPA's air quality standards, the peer reviewers recommended that the indicator present data on 1-hour average ozone concentrations based on running fourth highest daily maximum 1-hour ozone values over 3 years. This is the approach currently taken in *The Ozone Report* (EPA 2004, page 8).
- **Figures.** The peer reviewers recommended that EPA revise the figures in this indicator considering the suggestions listed under "General Issues for All Ambient Concentration Indicators." Of particular importance, two reviewers said EPA could greatly improve the figures by presenting trends in the number of monitoring stations with ozone levels above air quality standards. This additional information could either be superimposed on the existing plots or included in separate graphs. Given that ozone concentrations vary widely through certain regions (e.g., EPA Region 9), one reviewer suggested that EPA consider replacing the regional plots with county-level plots. For instance, the county-level information could be depicted using side-by-side maps: one based on data collected between 1980 and 1982 and the other based on the same monitors for data collected between 2002 and 2004. These maps could be color-coded to correspond with EPA's non-attainment designations for ozone (i.e., extreme, serious, severe, marginal), or else coded to show concentration ranges. The net effect would be plots similar to those shown in Figures 23 and 24 of *The Ozone Report* (EPA 2004). The reviewers did not unanimously agree on the need to replace the regional figures with county-level figures.
- **Other comments.** The reviewers repeatedly recommended that this indicator more prominently acknowledge the strong role that meteorology plays in ground-level ozone. Specific suggestions included displaying ozone monitoring data adjusted for meteorological conditions, as is done on page 13 of *The Ozone Report* (EPA 2004), and adding text to "What the Data Show" explaining that ozone concentrations exhibit considerable year-to-year variations most likely due to fluctuating meteorological conditions.

  The reviewers recommended that EPA consider several additional revisions to the indicator. First, they suggested that the text or the figure describe what is meant by the "ozone season" and describe the time frame (months) over which ozone measurements are recorded. Second, a reviewer recommended that the text provide additional context on how local emissions and long-range transport contribute to ground-level ozone problems. Third, one reviewer recommended that EPA consider separately tracking ozone trends in rural areas, possibly drawing from data collected by the CASTNet monitors.

Reference

EPA 2004. The Ozone Report: Measuring Progress through 2003. U.S. Environmental Protection Agency. EPA 454/K-04-001. April 2004.

2.2.2.11 Ambient Lead Concentrations

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• The indicator should provide additional context on the relative significance of lead exposures via ambient air as compared to exposures through other media. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators" and under "General Issues for All Indicators."
Other comments	• Reviewers offered several suggestions for how EPA can improve the text and associated interpretations. These suggestions are listed under "other comments" (see below).

The reviewers agreed that lead exposure continues to be an important environmental health issue, though exposures attributed to outdoor air pollution are probably insignificant in comparison to exposures through other pathways. The reviewers noted that EPA largely addressed concerns regarding lead in ambient air by phasing out leaded gasoline additives. Nonetheless, they recommended that this indicator remain in ROE06 to document a "success story" and that several minor revisions should be considered:

- **Underlying data sources.** Noting that the draft indicator is based on data collected at only 20 monitoring stations located in 8 states, the reviewers had some concerns about whether the site selection criteria excluded a large number of monitoring stations from the trend analysis. Further, by using only 20 monitoring stations, some reviewers had concerns about the confidence in the lines shown in Figure 005-1 for 10^{th} and 90^{th} percentiles.

  The reviewers had different recommendations for whether and how this issue should be addressed. One reviewer, for instance, suggested that EPA consider having this indicator present data for a different time frame such that the trends would be based on additional stations. Focusing on years when more stations monitored for lead (e.g., 1970 to 1995) might result in a larger number of monitoring stations included in this indicator. Other reviewers agreed that this recommendation would result in additional stations being included; however, they were not convinced that the resulting trends would differ considerably from what is already shown in the draft indicator.

  As another suggestion for including additional monitoring stations, one reviewer recommended that EPA consider including data from the IMPROVE network in this indicator; another reviewer cautioned against doing so due to difficulties inferring trends for measurements consistently near or below detection limits (as reportedly occurs for metals measured by IMPROVE stations).

- **Other comments.** Several reviewers recommended that the indicator include additional context on the relative significance of exposures via ambient air, as compared to exposures through other media. One reviewer recommended that EPA quantify and present confidence intervals on the reductions reported for lead concentrations. After hearing feedback provided during the observer comment period, the reviewers recommended that EPA verify the accuracy of the following statement in the indicator text: "Today, the highest levels of airborne lead are usually found near industrial operations that process materials containing lead, such as smelters and battery manufacturers."

2.2.2.12 Ambient Concentration of a Selected Air Toxic: Benzene

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include, unless critical modifications are made.**
Critical modifications	• By focusing on just one chemical, the indicator provides limited insights on the 188 air toxics as a whole. While the reviewers acknowledged that this indicator cannot present data on every air toxic, they strongly recommended that the indicator include ambient concentration data on additional air toxics of interest, such as those recommended for the updated indicator on air toxics emissions. The reviewers noted that a pending publication by Sonoma Technologies, Inc., prepared under contract to EPA, has ambient concentration trends that could be used to revise this indicator.
Suggested modifications	• EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators." EPA should also specifically consider the "General Issues for All Indicators."
Other comments	• Some minor revisions were noted during the discussions and are documented at the end of the text below.

The peer reviewers unanimously agreed that it is important to track changes in ambient concentrations of air toxics. They recommended that EPA include this indicator in ROE06, provided that critical modifications are addressed:

- **Provide data on additional air toxics.** The main limitation with the proposed indicator is that it presents ambient concentration trends for just 1 out of 188 air toxics. Because the data trends for benzene clearly do not represent air quality trends for all air toxics, the reviewers unanimously agreed that the indicator should present data for additional air toxics. Several reviewers recommended that the indicator present concentration trends (assuming the underlying monitoring data are adequate) for a small subset of air toxics of particular significance to human health—possibly the same toxics that the reviewers recommended EPA include in the updated indicator on air toxics emissions. Reviewers noted that this ambient concentration indicator would be more insightful if concentration trends were at least presented for different types of air toxics, such as a mobile source air toxic (e.g., benzene), an air toxic linked largely to industrial or commercial sources (e.g., tetrachloroethylene), and others. One reviewer noted that EPA must consider frequency of detection when selecting air toxics for this indicator, because concentration trends are expected to be highly uncertain for chemicals that are detected infrequently or consistently at levels near detection limits. Regardless of which air toxics EPA chooses to address, one reviewer noted that Sonoma Technologies, Inc., is about to publish ambient concentration trend data for numerous air toxics. Thus, the data needed to incorporate the reviewers' recommendation will be readily available.
- **Link concentration trends to emissions trends.** The indicator on ambient concentrations of air toxics will be much more informative if it considers the same substances as the indicator on air toxics emissions. Specifically, a reader can more easily interpret a downward trend in ambient air concentrations of benzene if a similar plot tracks emissions reductions, broken down by source category.

- **Other comments.** When commenting on the data specific to benzene, the peer reviewers noted that the indicator limitations should acknowledge both the limited number of monitoring stations and the limited geographic distribution of these monitoring stations. Another reviewer suggested that the indicator better describe how monitoring stations were selected for this indicator, given that some reviewers incorrectly assumed that the data trends presented were based entirely on PAMS monitoring.

2.2.2.13 Ambient CO Concentrations

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Suggested modifications	• Quantitative estimates of long-term trends should be based on more sophisticated statistical analyses (e.g., regression analyses), rather than simply comparing observations in 1980 to those in 2003. • EPA should make the additional suggested revisions identified in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators" and under "General Issues for All Indicators."
Other comments	• More contextual information is needed to highlight the fact that decreases in ambient air concentrations of carbon monoxide have occurred over a time frame when vehicle miles traveled increased.

The reviewers noted that ambient concentrations of carbon monoxide, though considerably lower than they were 25 years ago, are still an environmental health issue of concern and should therefore be discussed in ROE06. EPA should revise the indicator according to the following suggestions:

- **Statistical analysis.** Consistent with comments provided on other ambient concentration indicators, the peer reviewers recommended that EPA quantify long-term air quality trends using more sophisticated statistical approaches than simply comparing data from the endpoints of the time frame considered. Specific suggestions for quantifying these trends are presented in the "General Issues for All Ambient Concentration Indicators."
- **Figures.** The reviewers found the two figures to be useful but suggested several changes, such as: showing long-term trends in the number of monitoring stations with CO concentrations above EPA's air quality standards; tracking the median concentrations instead of the average concentrations in Figure 331-1; and other considerations mentioned in the "General Issues for All Ambient Concentration Indicators."
- **Additional contextual information.** The peer reviewers recommended that the indicator write-up acknowledge that air quality improvements for CO have occurred during a time when vehicle miles traveled have actually increased. The peer reviewers briefly discussed whether the indicator should present concentrations adjusted for meteorological conditions, but had differing opinions on whether using adjusted data would be helpful for this report.

2.2.2.14 Number and Percent of Days AQI Values >100

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include, unless critical modifications are made.**
Critical modifications	• The approach to calculating AQI values changed in 1999, when ambient concentrations of PM2.5 were first factored into this system. However, the indicator does not acknowledge this change in methodology and therefore presents a very misleading account of trends in AQI data over the past 15 years. The reviewers recommended several ways that EPA can address this issue (see below). • The number of AQI days greater than 100 in a given year can be highly influenced by meteorology. As a result, comparing AQI data from one year to AQI data in another year (e.g., 1990 vs. 2004) can be misleading. The reviewers recommended that EPA use more statistically robust approaches when commenting on long-term AQI trends (see below).
Suggested modifications	• Even though this indicator technically does not track ambient concentration trends, EPA should still make revisions listed in the Executive Summary under "General Issues for All Ambient Concentration Indicators." EPA should also specifically consider the "General Issues for All Indicators." • The reviewers listed specific revisions that EPA should consider for this indicator's graphic (see below).
Other comments	• Some minor revisions were noted during the discussions and are documented at the end of the text below.

The reviewers had various opinions on the importance of AQIs as an indicator. Some reviewers did not find the AQI particularly informative, noting that it basically correlates with data already presented in the ambient concentration indicators. Other reviewers noted that the public has become increasingly aware of the AQI, given that various media outlets now use AQI to provide "air quality forecasts." The reviewers eventually agreed that this indicator is of sufficient importance to remain in the ROE, but provided that EPA makes critical modifications. Detailed information on the reviewers' recommendation follows:

- **Addition of PM2.5 to AQI in 1999.** Figure 001-1 in the draft indicator suggests that the number of days with AQI greater than 100 changed little between 1990 and the present. However, the figure fails to account for the fact that, starting in 1999, EPA began factoring ambient air concentrations of PM2.5 into AQI calculations. Thus, the numbers of days with AQI greater than 100 from 1999 to the present are not directly comparable to those prior to 1999. In years since 1999, roughly 30 to 35% of days with AQI values greater than 100 are attributed to PM2.5 concentrations. By including PM2.5 starting in 1999, the figure actually masks a downward trend in AQI values attributed to ozone concentrations (see page 1-85 of the pre-meeting comment booklet).

  The peer reviewers agreed that this confounding effect is critical to address, both in the figure and in the text. The reviewers suggested two different approaches for revising the figure: (1) EPA could include two separate figures, one showing AQI values attributed to ozone and the other showing AQI values attributed to PM2.5 (including figures for other criteria pollutants was considered unimportant, given that ozone and PM2.5 account for the overwhelming majority of days with AQI values greater

than 100); or (2) EPA could include two separate figures, one showing AQI data for years before PM2.5 factored into the index and the other for years since PM2.5 has been considered. After recalculating the AQI data for the figures, EPA should then revise the text in "what the data show" accordingly. The peer reviewers concluded that these revisions are critical and must be incorporated if EPA intends to keep this indicator in ROE06. Peer reviewers also suggested that the figures be extended back to 1980, an issue that is critical because this indicator is highly subject to year-to-year meteorological variability.

- **Statistical analysis.** Given that meteorology can strongly influence AQI values in a given year, the peer reviewers strongly recommended that EPA revise statements in the text. Specifically, EPA should revise sentences that compare AQI values in one single year to those in another single year (e.g., "the percentage of days with AQI greater than 100 in 2003 is 27% lower than that for 1990"). To avoid potential biases introduced by years with unique meteorological conditions, the reviewers recommended that EPA instead consider comparing a 3-year average at the beginning of the period of record to a 3-year average at the end (again, see page 1-85 of the pre-meeting comment booklet for an example). This approach is already used in some EPA publications.
- **Figures.** The reviewers debated several different approaches to improving the presentation of the AQI data. One reviewer found Figure 001-1 somewhat confusing in that the number of days with AQI values greater than 100 was always greater than 365. Though he understood how these numbers were derived, the reviewer wondered if this presentation might confuse readers. On the other hand, several reviewers supported the use of percent of total days with AQI values greater than 100. Another suggestion was to present graphs that provide insights on the magnitude of the AQI values, not how often they exceed 100. The peer reviewers eventually recommended that EPA carefully consider these options and review existing plots in other OAR documents (i.e., trends reports) before revising the figures for this indicator.
- **Other comments.** The peer reviewers offered several suggestions for providing additional contextual information on AQI values and how to improve entries on the "metadata" form (see pre-meeting comments submitted by Dr. Fairley). Additionally, the reviewers recommended that the text more prominently acknowledge that the indicator applies exclusively to larger urban and suburban areas (i.e., MSAs with at least 500,000 residents).

2.2.2.15 Ambient Concentrations of Manganese Metal Compounds

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include.**
Critical comments	• The reviewers supported EPA's desire to include regional indicators in ROE06, but strongly recommended that EPA not include this indicator, primarily because it contributes little to answering the overarching question on ambient air quality, even on a regional scale. Additionally, the reviewers identified serious technical problems with the indicator and found the graphics to be very misleading.
Critical modifications	• Specific comments and modifications are provided below, in the event that EPA decides to include this indicator in ROE06. However, the reviewers clearly preferred that the indicator not appear in ROE06, even if substantial revisions are made.

The reviewers' primary reason for rejecting this indicator is that data on ambient air concentrations of manganese compounds in EPA Region 5 appear to characterize highly localized issues (i.e., air quality in the immediate vicinity of a small number of industrial facilities), rather than issues of regional interest. Thus, the reviewers concluded that this indicator does not offer important insight to the overarching question on outdoor air quality. Though they acknowledged that the indicator provides some insights on a very limited number of areas with large air emissions sources of manganese compounds, the peer reviewers noted many other pollutants (e.g., dioxin, hexavalent chromium) that EPA could examine in a regional indicator that would be of far greater importance.

The reviewers identified many regional indicators that can address more important issues related to outdoor air quality and that are of greater interest to a broader audience. For instance, regional indicators can examine how air quality varies between rural and urban settings or between the west coast and the east coast. Alternatively, a regional indicator might address a national issue that clearly has greater relevance to a specific region, such as acid deposition in the northeast and upper Midwest or air quality impacts associated with rapid population growth. The reviewers noted that presenting data on highly localized issues for a single pollutant seems arbitrary.

Following are some specific comments about the indicator text and graphics. The reviewers emphasized, however, that their preference is that EPA not include this indicator in ROE06 rather than simply making the changes listed below.

- **Figure 200R-1.** The map, while helpful in identifying the locations of monitoring stations, does not present clear information on the measured concentrations. The figure appears to depict average concentrations, but does not specify the time frame to which the averages correspond. The reviewers suspected that the average concentrations shown in the figure might have been calculated for different time frames for the different monitoring stations, which complicates efforts to interpret the data displayed. The reviewers noted that the map would be much more useful if it included the locations of major sources of manganese compound emissions.
- **Figure 200R-2.** The reviewers unanimously agreed that EPA must extensively revise this figure if this indicator will be included in ROE06. First, the reviewers said the graph should summarize the actual monitoring data (perhaps using distribution plots, as is done for almost every other figure on ambient air concentrations) rather than presenting regression lines generated from the actual data. Second, the reviewers noted that the graph or text should describe what tests were used to establish that some concentration decreases were statistically significant. Third, the reviewers recommended that the graph display data on a linear scale, rather than a logarithmic one, and that the graph indicate concentration levels corresponding to relevant health benchmarks (e.g., the reference concentration for chronic inhalation exposure).
- **Interpretations.** The draft indicator provides no broader context to interpret the data presented in the figures: Do the measured concentrations in Region 5 generally fall within the range of those observed nationwide? Does the apparent downward trend correspond to similar downward trends in emissions from certain facilities? Could the measured concentrations be influenced by mobile source emissions in Canada, where methylcyclopentadienyl manganese tricarbonyl (MMT) is used as a gasoline additive? For stations with only 4 years of data, how confident is EPA that the data are sufficient to support long-term trend analyses? Finally, one reviewer noted that the indicator is based on measurements of manganese within total suspended particulate (TSP)—a particulate size fraction that is not directly comparable to the smaller size fractions that are more commonly measured today.

2.2.2.16 Ozone and PM for the U.S./Mexico Border Counties

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include.**
Critical comments	• The reviewers supported EPA's desire to include regional indicators in ROE06, but strongly recommended that EPA not include this indicator primarily because it contributes little to answering the overarching question on ambient air quality beyond what other indicators already address. Moreover, the indicator leads a reader to believe that trans-boundary transport issues are to be addressed, when that issue is not discussed at all. The reviewers identified serious technical problems with the indicator and found the graphics to be misleading.
Critical modifications	• Specific comments and modifications are provided below, in the event that EPA decides to include this indicator in ROE06. However, the reviewers clearly preferred that the indicator not appear in ROE06, even if substantial revisions are made.

The reviewers' primary reason for rejecting this indicator is that data on ambient air concentrations of ozone and particulate matter in U.S./Mexico border counties do not provide any unique insights that are not already covered in other indicators on ambient air concentrations. The reviewers acknowledged that trans-boundary transport is an important air quality issue that a regional indicator could possibly address; however, this particular indicator, as written, provides no unique insights on trans-boundary transport phenomena. Thus, the reviewers concluded that this indicator does not offer important insight to the overarching question on outdoor air quality.

The reviewers noted that EPA could have considered many other regional indicators that (1) would provide an important contribution in addressing outdoor air quality and (2) are of greater interest to a broader audience. Refer to the summary of the previous indicator for the reviewers' specific suggestions.

Following are detailed comments about the indicator text and graphics. The reviewers emphasized, however, that their preference is that EPA not include this indicator in ROE06 rather than simply making the changes listed below.

- **Intent of including this indicator.** An implication of this indicator is that trans-boundary transport issues are important, but the indicator text does not acknowledge or evaluate this phenomenon even though a fairly extensive body of literature is available on such transport issues. The "metadata" form for this indicator explains that monitoring along the border region has been conducted "…to determine air pollution exposures in populated areas…" and "…to supply trends information for sensitive ecosystems." If this is the only unique aspect of this region, one reviewer questioned why the indicator did not instead focus on all areas with a growing population. The peer reviewers eventually agreed that this indicator does not present any unique information that is not already covered by other ambient air concentration indicators.
- **Inadequate spatial coverage of data.** The reviewers noted that the data presented in the indicator are not spatially representative of air quality along the U.S./Mexico border. The data shown (for only a subset of the U.S. border counties) do not characterize air quality along the entire border. Further, the

data provide no insights on ambient air concentrations measured in Mexico, even though such measurements are available. The reviewers noted that other indicators (e.g., mercury deposition) present measurements from outside the U.S., and wondered why this indicator does not. Finally, by presenting data at the county level, the indicator mixes measurements collected at stations within a few miles of the border with measurements collected at stations more than 20 miles from the border. Thus, if the indicator focuses on the border itself, then the monitoring stations selected are not reflective of this focus.

- **Inadequate temporal coverage of data.** The ambient air quality data for U.S. border counties are available for many years prior to 1997, at least for ozone and PM10. If this indicator is to remain in the report, the reviewers recommended that EPA include data for as many years prior to 1997 as possible, because doing so would provide a much more meaningful analysis of trends.
- **Other comments.** One peer reviewer noted that the figures' legends use inconsistent terminology: some plots (PM10 and PM2.5) have legends that refer to mean concentrations for an entire EPA region, while other plots (ozone) refer to mean concentrations for the border counties within an EPA region. EPA should correct the legends or explain why different groupings are used. Additionally, one reviewer questioned the accuracy of the data, given that the figures suggest that the El Paso metropolitan area is in attainment with the ozone and PM10 National Ambient Air Quality Standards, when he thought that currently is not the case.

2.2.2.17 Ozone Levels over North America

Reviewed by the Air Group and by the Ecological Condition Group (as a Referenced Indicator)

Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Suggested modifications	• Of all indicators proposed for the Air Chapter, the reviewers found this indicator most difficult to follow and recommended significant revisions to provide necessary context for understanding stratospheric ozone depletion and the significance of the data presented. • The indicator incorrectly states that Figure 015-1 is based on satellite data. In reality, the figure is based entirely on ground-level Dobson Spectrophotometer readings. • Figure 015-1 should be significantly revised to provide a more transparent account of data trends. Suggested revisions are presented below. • The indicator should describe the statistical methods used to quantify the magnitude of the downward trend and should specify whether this trend is statistically significant. • EPA should make the additional suggested revisions identified in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators" and "General Issues for All Indicators," to the extent that the suggested revisions apply.
Other comments	• The reviewers recommended that EPA consider including data, either within this indicator or as a separate indicator, on the amount of ultraviolet (UV) radiation that reaches the Earth's surface. Data are currently available from an existing NOAA monitoring network to support such an indicator (see below).

Because depletion of stratospheric ozone poses potentially significant consequences to both human health and the environment, the peer reviewers found this indicator to provide appropriate, adequate, and useful insights into the overarching question on our nation's air quality. Although they agreed that the indicator tracks an important environmental issue, the reviewers also agreed that the draft indicator is very difficult to follow and requires major revisions before being included in ROE06:

- **Additional contextual information.** Finding the indicator text difficult to comprehend, especially for readers who might not be familiar with stratospheric ozone issues, the reviewers recommended that EPA carefully revise the text to include additional contextual information on many issues. For instance, one reviewer thought the text could include one or two more sentences to better describe the fate and transport of ozone-depleting substances and their atmospheric chemistry. Additionally, context is needed to inform the reader of how much "total column ozone" is found in the stratosphere versus the troposphere. Further, several reviewers were concerned that the indicator does not explain that stratospheric ozone depletion results from releases of ozone-depleting substances from sources *around the world;* without this context, the reviewers feared, a reader might infer that stratospheric ozone depletion is caused only by releases from the United States. The reviewers recommended that the indicator text include estimates of how much stratospheric ozone depletion is attributed to releases

from domestic sources, to the extent this information is known. Similarly, the peer reviewers recommended that the text provide some context on how the depletion observed across North America compares to the depletion observed in other specific areas, such as polar regions.

The reviewers also noted that readers would benefit from additional discussion on the significance of the trends: Is a 3% decline in "total column ozone" between 1979 and 2003 notable? How does this decline compare to observations from earlier years? How does this decline translate into increased exposure to UV radiation? Would this decline be expected to cause increases in adverse health effects, like skin cancer and cataracts? For additional background information, some reviewers recommended that this indicator include maps (i.e., similar to Exhibit 1-26 in ROE03) to illustrate the spatial extent of stratospheric ozone depletion.

- **Underlying data sources.** The indicator text currently states: "Data mapped for this indicator are derived chiefly from the Total Ozone Mapping Spectrometer (TOMS), flown on NASA's Nimbus-7 satellite." Noting that the indicator appears to be based entirely on surface-based Dobson Spectrophotometer readings, the peer reviewers recommended that EPA correct this statement.
- **Figure 015-1.** Finding it difficult to visualize trends from the current version of Figure 015-1, the reviewers recommended several alternate approaches to presenting the data. For instance, by displaying only annual average or running annual average observations of "total column ozone," the figure would show a smooth signal that is not obscured by the significant seasonal variations. Additionally, given that all four monitoring stations have nearly identical data, some peer reviewers recommended that the graph present average readings from all stations combined or perhaps just present data from a single station and note that trends observed at other stations are basically the same. Finally, a reviewer recommended that the y-axis on the graph be extended to zero, which would show the trends on an absolute scale and not give the appearance of the decline being larger than it actually is.
- **Statistical analysis.** The indicator currently states: "…the global-average total column ozone during the period 1997 to 2001 was about 3 percent below average pre-1980 values." The reviewers had several questions about this statement: What is the magnitude of the downward trend for the stations presented in Figure 015-1? Is the downward trend statistically significant? If so, how was the statistical significance established? Given that "total column ozone" levels vary by approximately 20% from one season to the next, how confident is EPA that a downward trend of 3% can be reliably measured?
- **Use of UV radiation data.** For more direct insights on exposures associated with stratospheric ozone depletion, the reviewers recommended that EPA consider tracking measurements of UV radiation at the Earth's surface. Such information is already being collected in NOAA's Surface Radiation Budget Network (or SURFRAD), described further online at http://www.srrb.noaa.gov/surfrad. The network currently consists of seven monitoring stations established at different times over the last 12 years. The reviewers recommended that EPA consult with NOAA on the utility of these data as an environmental indicator in ROE. One reviewer also recommended that EPA access UV radiation data from the Atmospheric Radiation Measurement (ARM) network, described further online at http://www.arm.gov.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: Medium)
Critical modifications	• Graphical information on continental and global patterns would provide useful context.
Suggested modifications	• Show trend lines in the graphics if appropriate.
Other comments	• The indicator is ecologically important, particularly for aquatic systems.

Individually, the reviewers expanded upon their recommendation to provide global context for the current data. One reviewer emphasized that contextual information would help the audience interpret the problem—i.e., whether the trends in the graphic reflect a global phenomenon, a North American phenomenon, or something specifically related to stressors within the U.S. Two reviewers suggested adding graphics to provide global context, and one specifically suggested adding a graphic sidebar like the "Global Mean Temperatures" figure in the indicator on temperature and precipitation trends.

Noting that trends from the four stations track one another, a reviewer wondered if similar patterns would be seen at stations further north. However, others suggested leaving that question to the Air chapter reviewers.

Focusing on the ecological implications of changes in stratospheric ozone, one reviewer pointed out that this indicator is particularly relevant to aquatic systems, since UV light photoactivates PAHs, increases the prevalence of free radicals in the water, and affects electron transfer systems. The reviewer noted that terrestrial ecosystems are also affected, citing work by Paul Barnes.

2.2.2.18 Concentrations of Ozone-Depleting Substances

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Do not include, unless critical modifications are made.**
Critical modifications	• The indicator focuses on a subset of ozone-depleting substances that (based on the 2001 data shown) appear to account for approximately two-thirds of the total concentration of ozone-depleting substances. The reviewers strongly recommended that the indicator include data for additional substances, if available, or more prominently acknowledge and explain the significance of these substances' omission. • Presenting a weighted index could mask important substance-specific trends, and focusing on 1991 to 2001 leaves out over 10 years of relevant measurements. The reviewers recommended that this indicator, to the extent possible, include substance-specific data over longer time frames. Reviewers noted that the data and graphs should be available from the National Oceanic and Atmospheric Association (NOAA).
Suggested modifications	• EPA should make all applicable revisions identified in the Executive Summary under "General Issues for All Ambient Concentration Indicators." EPA should also specifically consider the "General Issues for All Indicators."
Other comments	• Some minor revisions were noted during the discussions and are documented at the end of the text below.

The reviewers unanimously agreed that this indicator provides an important contribution to the overarching question regarding ambient air quality, due to the insights offered on stratospheric ozone issues. However, the reviewers also agreed that revisions to the indicator are needed to provide a more meaningful account of ozone-depleting substances. Specific revisions follow:

- **Omission of other ozone-depleting substances.** The "indicator limitations" section currently notes that "persistent chemicals not monitored in this indicator (such as methyl halides and lesser halocarbons) contribute an additional 900 ppt to the effective equivalent chlorine (EECl) in today's atmosphere." The peer reviewers found this limitation quite significant, considering that the indicator reports a decline in EECl between 1991 and 2001 of approximately 150 ppt. Based on these observations, they questioned the significance of the 6% decrease in EECl (see Figure 017-1) when nearly one-third of the substances were not considered in the trend analysis. To address this concern, the reviewers recommended that EPA include data on a greater range of ozone-depleting substances or more explicitly describe the potential implications of the substances' omission.
- **Figure 017-1.** Some reviewers noted that the data processing steps taken to develop Figure 017-1 were not transparent. It is not clear, for instance, that the single line shown in the figure is a composite of measurements taken at multiple stations for multiple chemicals. The reviewers recommended three changes to the figure: (1) Given that the weighted index potentially masks important substance-specific trends, the reviewers recommended that the indicator report data for specific substances. Such plots are already available from the National Oceanic and Atmospheric Association. (2) The reviewers recommended that the plots show data for individual monitoring stations (e.g., see ftp://140.172.192.211/hats/graphs/cfc11_1.gif) to more clearly demonstrate that

concentrations of these substances in the troposphere are relatively constant—an important insight that the indicator currently does not convey. (3) The plots should display data for additional years, especially for the 1970s and 1980s.

- **Other comments.** Additional context should be provided in the indicator text to explain why ambient concentrations of ozone-depleting substances are decreasing so slowly, even though the Montreal Protocol was ratified nearly 20 years ago. For a more complete picture on stratospheric ozone issues, the peer reviewers recommended that EPA make the revisions necessary to retain this indicator and that EPA not withdraw the indicator on production of ozone-depleting substances.

2.2.2.19 Atmospheric Deposition of Mercury

Reviewed by the Air Group and by the Ecological Condition Group (as a Referenced Indicator)

Air Group

Consensus Statements	
Overall recommendation	**Do not include.**
Critical comments	• Without presenting data or context on dry atmospheric deposition of mercury, the reviewers wondered if the indicator fails to track the most important contributor to total atmospheric deposition. • The indicator presents data from only 1 year of sampling, which does not meet the indicator criteria of describing changes or trends. Further, by focusing on a single year, the spatial trends shown can be biased by meteorological conditions (especially precipitation totals), which vary from one year to the next. • The reviewers found some of the spatial trends depicted counterintuitive, causing them to question the representativeness of the underlying data set.
Critical modifications	• Specific comments and modifications are provided below, in the event that EPA decides to include this indicator in ROE06. However, the reviewers recommended that the indicator not appear in ROE06 in its present form.

The reviewers generally agreed that mercury deposition is an important environmental issue to track, given that this phenomenon ultimately contributes to the mercury levels in aquatic ecosystems. However, the reviewers found the draft indicator to be flawed to such an extent that they eventually agreed that it should not be included in ROE06. (One reviewer noted that there is still potential for this indicator to be included in future ROEs, which might be important as the Clean Air Mercury Rule and other legislation are promulgated.) More detailed information on the reviewers' comments follows:

- **Significance of omitting dry deposition.** Failure to present information on dry deposition was viewed as a critical flaw in this indicator. The reviewers recognized that sampling limitations and other factors might currently prevent widespread tracking of dry deposition; however, the indicator provides no context on just how significant dry deposition might be (e.g., Does dry deposition account for 10% of total mercury deposition? Or does it account for 90%?). Assuming that total atmospheric loading of mercury is the most important loading for aquatic ecosystems, the reviewers found the lack of information on dry deposition to be a very significant omission. While they agreed that this indicator should not be included in ROE06, the reviewers suggested that EPA at least rename

the indicator to "Wet Atmospheric Deposition of Mercury" should the agency decide to include a modified form of the indicator in the report.

- **Lack of trend data.** The reviewers had two concerns about basing an indicator on a single year of data even though data for several additional years appear to be available. First, focusing on one year of data does not meet EPA's indicator criteria of using data that can characterize trends. (The data presented allow for characterization of spatial variations, but not temporal trends.) Second, the reviewers feared that the data might be biased by meteorological conditions, which can vary considerably from one year to the next. As an example of this concern, some reviewers wondered if Figure 038-2 basically shows spatial patterns in precipitation, with little insight offered on mercury.
- **Context.** The indicator write-up, several reviewers commented, provides little of the contextual information a reader would need to understand the underlying data. For instance, if power plants are believed to be the most significant anthropogenic emissions source of mercury in the United States, then why are the spatial patterns in the figure not more similar to those shown for acid deposition? And why is the highest mercury concentration in precipitation observed in New Mexico? To what extent is deposition influenced by anthropogenic/non-anthropogenic emissions sources and domestic/foreign emissions sources? The reviewers agreed that, should EPA decide to keep this indicator in ROE06, additional context is needed to understand these trends.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• It would be useful to present more data on possible trends. As noted in the indicator text, at least 13 sites should have wet deposition data for mercury over the full period 1995-2003.
Suggested modifications	• It would be useful to include more sampling from Western sites. • It would be useful to supplement the wet deposition data with any dry deposition data that are available. • The absolute loading of mercury is an important stressor. However, as science and technology permit, it would also be useful to present corresponding regional rates of methylation of mercury.

Noting that the NADP has collected mercury data since 1995, two reviewers wondered why this indicator provides just a single snapshot in time. Another reviewer clarified that many of the NADP sites have been added since 1995, noting that only 13 were sampled in the first year of the program. However, the reviewers all agreed that it would be useful to see trends for those sites that do have several years of data (see critical modification above). One reviewer also pointed out that NADP has some long-term mercury data, but has not yet worked the data into a trend analysis.

Individual comments also highlighted spatial limitations of the indicator. One reviewer agreed that it made sense to focus sampling on the East, since coal burning is the mercury source of greatest concern. However, another argued that sampling was too limited in the West, where a big concern is windblown mercury from mining activities. Another reviewer pointed out additional sources of mercury, noting that the high mercury deposition in Florida is believed to be due in part to windblown dusts from North Africa as well as waste incineration within Florida.

Much of the reviewers' discussion focused on the ecological implications of mercury deposition. One reviewer noted that ecological effects are directly tied not to the rate of deposition, but to the rate at which mercury is methylated, which varies across the nation. Although another reviewer emphasized that deposition is still the overall stressor, some members of the group expressed interest in developing a map showing methylation rates across the U.S. One reviewer suggested that Eh (redox potential) would be a good proxy for methylation potential. However, another reviewer commented that it is hard to represent the exact pathway of methylation, and also wondered where Eh would be measured, since it depends where the sample is taken, even within a single wetland. Still, a reviewer pointed out that methylation models have already been developed for San Francisco Bay.

2.2.2.20 Acid Deposition

Reviewed by the Air Group and by the Ecological Condition Group (as a Referenced Indicator)

Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• EPA should make suggested revisions listed in the Executive Summary of this section under "General Issues for All Indicators," to the extent that they apply. • Additional contextual information should be included in the indicator text, and some statements should be clarified.
Other comments	• EPA should consider revising the figures based on the reviewers' feedback (see below). At a minimum, higher resolution figures must be included in ROE06, because the data points in Figures 011-1 and 011-2 and the pie charts in Figures 011-3 and 011-4 are currently illegible.

The reviewers agreed that acid deposition continues to be an important environmental issue that is entirely appropriate to track in ROE06. The reviewers classified their suggested revisions to this indicator as being minor:

- **Additional contextual information.** The reviewers suggested minor revisions to the indicator text to clarify certain statements about acid deposition. First, one reviewer recommended that EPA revise the text to identify the specific geographic regions where various environmental effects have been observed, rather than listing general effects associated with acid deposition without any context on what parts of the country are most affected. One suggestion was to include references to other ROE indicators (e.g., "Lake and Stream Acidity") that characterize effects associated with acid deposition. Second, the reviewers recommended that EPA clarify the terminology used to refer to the different types of deposition, as it was not clear to everyone why the wet deposition figure refers to "nitrate" and the dry deposition figure refers to "total nitrogen." Third, one reviewer asked EPA to revise the sentence that reads "…acid deposition causes soils…to acidify." The reviewer explained that acid deposition causes only certain types of soils to acidify.
- **Figures.** The reviewers unanimously agreed that the data points and pie charts on the draft figures are completely illegible. Accordingly, EPA needs to update the figures, possibly preparing them at a finer resolution, such that all information on the figures is legible in the final report.

Individual reviewers suggested additional revisions to the figures, but no consensus was reached on these revisions. For instance, some reviewers recommended that EPA replace the contoured maps with maps showing average acid deposition data for the EPA regions, following the format used for the regional figures used in the ambient concentration indicators. Use of such maps would better capture the temporal trends in acid deposition, rather than simply comparing baseline and current conditions. On the other hand, other reviewers liked the spatial resolution offered by the draft figures and feared that averaging data over the EPA regions would mask the finer spatial trends currently depicted in the maps.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• It would be useful to present corresponding regional rates of acid neutralizing capacity (ANC) for both water and soil. • Trend data from the NADP, which are more extensive than the current snapshots, should be developed either for the nation or for regions.

In their discussion, several reviewers emphasized that while deposition is the stressor, *susceptibility to acidification* shows where deposition will really cause an ecological problem. One reviewer suggested adding a second national map showing ANC or soil buffering capacity. Another reviewer suggested looking at aluminum availability.

A reviewer also pointed out that while the 2-year snapshots in Figures 3 and 4 are useful, they are just a partial representation of a larger database. The reviewer suggested using histograms to show the full extent of NADP's trend data.

2.2.2.21 Visibility

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Suggested modifications	• The text and figures should be revised to acknowledge that the indicator does not present visibility measurements. Rather, it presents visibility data calculated from speciated PM measurements. • EPA should consider including data on visibility in urban areas, possibly drawing from visibility measurements collected at airports nationwide under FAA's Automated Surface Observing System (ASOS) network. If the urban data are not included, EPA should rename the indicator to be more descriptive of its contents (e.g., "Regional Haze" or "Visibility in National Parks"). • The reviewers recommended several revisions to the figure (see below). These suggestions should be specifically considered, along with suggested revisions listed in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators" and under "General Issues for All Indicators."
Other comments	• Several suggested revisions to the indicator text are listed below.

The reviewers agreed that impaired visibility, while not a health or environmental issue, is an important aesthetic issue of great concern to many people. For this reason, they recommended that the visibility indicator remain in ROE06, though major revisions must be made to clarify the indicator's messages:

- **Calculated visibility.** The reviewers emphasized that the indicator does not present direct measures of visibility. Rather, the indicator presents computed visibility statistics, which appear to be derived from ambient air concentrations of particulate species measured at IMPROVE monitoring stations. Accordingly, the reviewers recommended that this indicator (and its "metadata form") explain how visibility data are actually calculated and that the indicator, where appropriate, refer to "calculated visibility" instead of referring simply to "visibility."
- **Visibility outside Class I areas.** The proposed indicator is limited to observations in "Class I" areas, even though visibility impairment in urban areas is a very important issue to many people. Moreover, the peer reviewers wondered if urban visibility can be addressed in this indicator using visibility data collected at airports as part of FAA's ASOS network. The peer reviewers recommended that EPA either include the airport data for a much broader account of impaired visibility in the United States or change the indicator title to be more descriptive of what is actually shown (e.g., "Regional Haze" or "Visibility in National Parks").
- **Figures 006-1 and 006-2.** The reviewers recommended several changes to the visibility figures. First, several reviewers noted that the figures should include visibility data for years 2002 and 2003 (and 2004, if available) and should include data for years prior to 1992. Second, for greater consistency throughout the Air Chapter, the reviewers recommended that EPA consider presenting the visibility data in the same format used in the figures for the ambient concentration indicators: distribution plots showing the median, 10^{th} percentile, and 90^{th} percentile values. Third, again in the interest of greater consistency, some reviewers suggested that this indicator include another figure showing calculated visibility broken down by EPA region. Additional figures showing visibility trends in urban areas will

need to be developed, depending on EPA's response to the recommendations in the previous bulleted item.

- **Improved statistical analysis.** The reviewers noted that the section on "What the Data Show" does not attempt to quantify temporal trends in calculated visibility. Visual inspection of the figures suggests that the best visibility conditions might be improving; however, regression analyses or some other statistical analyses are needed to confirm whether this trend is indeed occurring. The reviewers recommended that EPA either specify in this section that certain conditions or improving (as backed up by statistical analyses) or acknowledge that no statistically significant temporal trends are apparent. Given the downward trend report for PM10 concentrations, some reviewers expected to see greater improvement among the visibility data.

Specific text revisions. The reviewers recommended three additional minor revisions to the text. First, the text should use a map to define the difference between "east" and "west" for purposes of visibility assessment. Second, the text should identify the number of monitoring stations located in the "east" and "west" regions. Third, the indicator text should include side-by-side haze photographs to provide visual perspective on what impaired visibility looks like. Examples of such displays can be viewed online at http://www.epa.gov/air/visibility/index.html.

2.2.2.22 Ozone Injury to Forest Plants

Reviewed by the Air Group and by the Ecological Condition Group

Air Group

The peer reviewers of the Ecological Condition Chapter evaluated this indicator in detail. The peer reviewers of the Air Chapter, on the other hand, were asked to comment on limited aspects of the indicator. Generally, the peer reviewers of the Air Chapter agreed that this indicator is appropriate, adequate, and useful and could provide an important contribution to potential effects of air pollution. However, the reviewers recommended several key improvements to the draft indicator:

- The indicator text implies that ozone injury data are available dating back to 1994, but no information on temporal variations is presented. The reviewers recommended that the indicator provide some perspective on whether the reported damage has increased or decreased over the last 10 years.
- The reviewers were concerned that the coarse resolution used for the four geographic regions might mask important spatial variations over finer scales. As an example of their concern, the "west" region includes Oregon and Washington, which have fairly extensive forests but relatively low ozone concentrations. But this region also includes California, which has less extensive forest and some of the highest ozone concentrations in the country. As a result, the reviewers wondered if using finer resolution for this and the other regions might reveal greater insights into ozone damage to trees.
- The reviewers recommended that EPA provide greater context for explaining the spatial variations depicted. For instance, the reviewers were surprised that the indicator reports such limited damage to trees in the west region, given the high levels of ozone routinely measured there. This unexpected trend raised several questions: Are the selected tree species in the west more resistant to ozone damage than are tree species elsewhere? Or might the relatively little damage in this region be caused by the forests in Oregon and Washington being sampled more extensively than those in California? Providing additional context in the text will help readers understand trends that otherwise seem counterintuitive.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: Medium) (but do not include unless greater spatial resolution can be provided)
Critical modifications	• The data were collected very precisely using many sites and a rigorous biosite value method. The data on over 1,000 sites seem to be a rich source of ozone injury data and were likely developed in a relatively unbiased manner. However, the indicator, as presented, is a poor use of these data. Averaging of the ozone data over such large (and administratively defined) regions is going to obliterate areas of concern. Since the focus is on forested areas, how can the regions include vast areas of the central U.S. that are largely without forested land? This tends to skew the data presentation further. The indicator must present data at a greater spatial resolution.
Suggested modifications	• There is uncertainty about the interpretation of the biosite values and associated possible impacts in relation to plant mortality or growth. Other patterns could emerge if suites of different organisms (e.g., understory species, lichens) were incorporated into the metric. It is difficult to infer broader ecological impacts from these results. Differential sensitivity among plants and different plants across regions make this index additionally challenging to interpret. The indicator should address any potential biases related to the differences in sensitivity in these organisms.

As noted under "critical modifications" above, the reviewers felt strongly as a group that this indicator should only be included in ROE if it can be presented at a higher spatial resolution. Individual concerns included the following:

- The present map is too coarse and it "dumbs down" the data.
- The regions used on the map are not explained or justified.
- Ozone damage near San Francisco and Los Angeles has been well documented, yet the map is too coarse to show this damage.
- Other Western cities have ozone problems as well. Why not show all 1,000 data points?

One reviewer warned that it might be hard to agree on a proper pixel size, as previous work on ozone damage (Peter Woodbury) has shown that pixel size has a huge influence on overall results. However, the reviewers all agreed that the present map is inadequate.

Reviewers also discussed the relationship between exposure and terrain. One reviewer noted that regardless of terrain, damage should be correlated with ozone concentrations. Another added that high-elevation species have evolved to handle different stresses—including higher ozone—but emphasized that the problem really lies in the impact of anthropogenic changes in ozone concentrations.

Several reviewers inquired about the representativeness of the sample. One reviewer noted that the indicator is not based on a probability sample, although EPA clarified that there should be enough samples to at least make the dataset useful on a national level. Reviewers also discussed interpolation between points, with one suggesting that it could be useful to create ozone injury polygons.

The reviewers disagreed on the possible biases inherent in limiting the measurements to a set of ozone-sensitive species. Several comments suggested a potential for bias, including the following key points:

- The survey *does not* look at total foliar damage; it is completely limited to a few sensitive species.
- Other plants and animals may be more or less sensitive to ozone, so the damage to sensitive species may not reflect damage to all species.
- Some regions may have more sensitive plants. The reader might be misled into thinking these regions must therefore have higher ozone levels.
- There may indeed be regional biases in sensitivity, considering that all the sensitive species listed in the table in the write-up happen to be Eastern.

Other comments argued that there is no significant bias. Noting an analogy to acid rain, one reviewer emphasized that susceptibility or sensitivity is not a bias; it is a part of what *should* be measured. The reviewer emphasized that the point of the indicator is to measure ecological impacts; thus, the indicator should tell the audience whether the forest at any given location is affected by ozone. If one location happens to have sensitive species, it just means that there is a higher chance of finding damage there; it does not mean the indicator is inaccurate.

Despite their disagreement, the reviewers agreed that EPA should revisit the issue of sensitivity bias, and at least provide a better explanation in the text. One reviewer specifically suggested a cautionary note explaining that damage could be the result of *either* high ozone or high sensitivity.

The reviewers also discussed whether the indicator should appear in the Air chapter or the Eco chapter, with arguments in favor of both options. One reviewer suggested that it would be nice to see exposures and effects mapped together. Another felt that this indicator should be in the Air chapter because it helps to explain what effects tropospheric ozone can cause. However, other comments favored placing the indicator in the Eco chapter, since it is clearly focused on ecological effects.

Finally, one reviewer strongly suggested discussing this indicator with Peter Woodbury, who is a leading expert in the field.

2.2.3 GREENHOUSE GAS EMISSIONS AND CONCENTRATIONS

2.2.3.1 U.S. Greenhouse Gas Emissions

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• The indicator should identify specific greenhouse gases and emissions sources that are not included in the emissions inventory and describe the potential significance of their omission. • The indicator should provide some sense for the extent to which the U.S. contributes to worldwide total greenhouse gas emissions. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Emissions Indicators" and under "General Issues for All Indicators," to the extent that these revisions apply.
Other comments	• Several additional suggested revisions are listed below, both for the indicator text and figures.

The reviewers agreed that indicators related to global climate change should definitely be included in ROE and that greenhouse gas emissions provide important insights on factors that contribute to climate change. The reviewers recommended that EPA make numerous revisions to this indicator, though they classified all of the following revisions as minor:

- **Significance of greenhouse gases not included in the inventory.** The reviewers noted that the indicator text should acknowledge that the greenhouse gas emissions inventory is not comprehensive, and that several greenhouse gases are currently not tracked in the inventory. The reviewers were specifically concerned that data are not included on chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs). When asked to clarify the potential significance of these greenhouse gases, an EPA representative noted that the chemicals might contribute a substantial portion of the total nationwide greenhouse gas emissions; however, these emission estimates have considerable uncertainty and the CFC and HFC emissions are expected to decrease considerably given that new uses of these chemicals in the United States are extremely limited. Based on these discussions, the reviewers recommended that the indicator quantify the significance of these gases' omission from the emissions inventory, whether in Figure 348-1 or in the indicator text. The reviewers also agreed that the indicator should mention that ozone is a greenhouse gas, though they acknowledged that quantifying emissions would be difficult because most airborne ozone is formed in the atmosphere and not emitted directly from a source.
- **Significance of emissions sources not included in the inventory.** The reviewers identified some potentially significant sources of greenhouse gas emissions (like wildfires and prescribed burns) that are apparently not tracked in the emissions inventory. The reviewers did not suggest that every single source must be quantified, but they recommended that the indicator identify, possibly in the "Indicator Limitations" section, whether any large sources or groups of sources are not included.

- **Global context on greenhouse gas emissions.** The indicator currently presents best estimates of the greenhouse gas emissions from the United States, but provides no context on how these emissions compare to those released worldwide. Given that climate change issues are of a global nature, the reviewers recommended that EPA provide some perspective on how greenhouse gas emissions from the United States are believed to compare to the worldwide totals. Some reviewers suggested that EPA present such information on a "per capita" basis or a "per gross domestic product basis."

- **Figures 348-1 to 348-4.** The peer reviewers had several comments on the proposed figures. Overall, they recommended that revised versions of Figures 348-1 and 348-2 remain in the report and that Figures 348-3 and Figure 348-4 be removed from the report, given that the underlying messages of these figures can easily be described in one or two sentences in the indicator text.

  Following are the specific revisions that the reviewers recommended for Figures 348-1 and 348-2: to the extent possible, use formats consistent with the other air emissions indicators; the revised figures should be prepared in much higher resolution to improve legibility; and include data for years prior to 1990 and since 2002, if these data are available. The reviewers also recommended that EPA revise Figure 348-2 using source categories more consistent with those presented in the other emissions indicators. One concern the reviewers had about this figure is that it currently gives the impression that greenhouse gas emissions are split among many different types of sources; however, some reviewers felt a more important message to convey is that fossil fuel combustion (whether for electricity generation, other industrial operations, or mobile sources) accounts for an overwhelming majority of the U.S. greenhouse gas emissions—a fact that is not readily apparent from Figure 348-2 due to the different categories used.

- **Confidence in the emissions inventory.** The reviewers agreed that this indicator should briefly discuss the relative confidence in the emissions inventory for individual greenhouse gases. In the case of carbon dioxide emissions, some reviewers suspected that the inventory is fairly robust, given that the predominant sources (i.e., fossil fuel combustion sources) have been extensively studied over the years. The reviewers suspected that the confidence in the inventories for methane and nitrous oxides were far less developed, and they recommended that the indicator text acknowledge this.

- **Additional contextual information.** Several minor revisions were recommended to the text to provide the reader more clear insights on how greenhouse gas emissions relate to climate change. First, surprised that the indicator text does not describe potential consequences of climate change, one reviewer recommended that such information be included somewhere in ROE06, whether in this indicator or elsewhere in the report. This reviewer cited several examples of consequences that could be mentioned: droughts leading to food shortages, increased severity and frequency of storms, melting of glaciers, and others. Second, a reviewer encouraged EPA to clarify the term "electricity generation" in the context of greenhouse gas emissions, because only electricity generating facilities that burn fossil fuels are of particular concern for this issue. For nuclear power plants, solar energy facilities, wind farms, hydroelectric dams, and other electricity generating facilities, greenhouse gas emissions are not nearly as significant. Third, one reviewer was concerned that the indicator text currently discusses greenhouse gas emissions from very specific sources (e.g., electricity generating facilities, mobile sources, industrial sources), while not emphasizing the much broader issue of fossil fuel combustion as the main source of greenhouse gas emissions in the United States. He recommended that the indicator text clearly state, quantitatively if possible, the contribution of all fossil fuel combustion sources to the total United States inventory, before breaking the emissions sources up into smaller categories.

2.2.3.2 Atmospheric Concentrations of Greenhouse Gases

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• The indicator should better explain that the concentrations presented are believed to be globally representative and that they reflect contributions from emissions sources worldwide. To the extent possible, the indicator text should provide some sense for the extent to which the U.S. emissions have contributed to the trends in atmospheric concentrations of greenhouse gases. • EPA should make the suggested revisions identified in the Executive Summary of this section under "General Issues for All Ambient Concentration Indicators" and under "General Issues for All Indicators," to the extent that these revisions apply.
Other comments	• Several additional suggested revisions are listed below, both for the indicator text and figures.

The reviewers agreed that indicators related to global climate change should definitely be included in the ROE, even if links between atmospheric concentrations of greenhouse gases and specific health and environmental effects are not yet firmly established. The reviewers recommended that EPA make numerous revisions to this indicator, though they classified these revisions as minor:

- **Global context on atmospheric concentrations of greenhouse gases.** The reviewers recommended that EPA revise the indicator to better describe the global context for the data presented. First, the text should explain that the measured concentrations were collected at monitoring stations that were specifically selected to be globally representative. Second, the text should explicitly note that the measured concentrations result from emissions sources worldwide, not just those in the United States. Third, the text should give some estimate, to the extent possible, for how emissions from sources in the United States (as opposed to worldwide) contribute to the concentration trends.
- **Figures 349-1 to 349-4 and their associated interpretations.** The peer reviewers had several comments on the proposed figures. For instance, given the importance of concentrations of greenhouse gases, the reviewers recommended that EPA use larger, clearer figures for this indicator in ROE06, even if the figures end up spanning more than one page. Comments specific to the individual figures follow:
  - For Figure 349-1, the reviewers liked how all graphs had y-axes drawn to the same scale, which allows readers to appreciate how concentrations of carbon dioxide in recent years are much higher than those measured over the last several hundred years. The reviewers recommended that EPA remove the labels (d), (b), and (a) from the individual graphs or explain what these labels mean.
  - For Figure 349-2, the reviewers recommended that all graphs have y-axes drawn to the same scale, as was done for Figure 349-1. Similarly, they suggested that EPA remove the labels (e), (c), and (b) from the individual graphs or explain what these labels mean. The reviewers also questioned whether the trend shown in Figure 349-2 supports the following statement in the

indicator text: "…rates of increase [in methane concentrations] have slowed almost to zero in recent years." EPA should verify that this statement is true and clarify the text accordingly.

- For Figure 349-3, the reviewers recommended that both graphs have y-axes drawn to the same scale.
- The indicator text does not explain the trends shown in, or even refer to, Figure 349-4. The reviewers recommended that EPA add some text to explain the data shown in the figure. Further, EPA should ensure that the text in the fourth paragraph under "What the Data Show" is consistent with the figure. Currently, the first sentence in the paragraph lists several gases for which atmospheric concentrations peaked in 1994 and are currently decreasing, but none of the data shown in Figure 349-4 depict such a trend. The reviewers recommended that EPA revise the text to better describe trends shown in Figure 349-4 and that EPA include references as appropriate when presenting trend data that are not depicted in any of the figures.

- **Additional contextual information.** Two minor revisions were recommended to the text to provide the reader context for understanding the importance of atmospheric concentrations of greenhouse gases. First, one reviewer again recommended that information on the potential consequences of climate change be included somewhere in ROE06, whether in this indicator, the previous indicator, or elsewhere in the report. Second, the reviewers recommended that EPA either include figures on other greenhouse gases (e.g., ozone) if data are available or note in the text (possibly in the "Indicator Limitations") that data are presented for only a subset of the known greenhouse gases.

2.2.4 INDOOR AIR QUALITY

2.2.4.1 U.S. Homes Above EPA's Radon Action Level

Reviewed by the Air Group

Consensus Statements	
Overall recommendation	**Include with suggested revisions.**
Critical modifications	None.
Suggested modifications	• Figure 013-1 currently implies that the number of radon mitigation systems being installed outpaces the number of new homes being constructed in areas believed to have radon levels greater than EPA's action level (4 pCi/L), when the opposite is true. The figure will not be misleading if the two data series are plotted on the same scale.
Other comments	• Additional context is needed to help readers understand where radon levels are believed to be highest and the percentage of new homes being constructed in these areas. • Some reviewers questioned whether the underlying data truly meet EPA's indicator definition (i.e., "…an indicator is a numerical value derived from actual measurements…"). These reviewers recommended that the indicator text clearly explain exactly how the underlying data were calculated and identify all associated uncertainties and limitations.

The reviewers had initial concerns about the importance of this indicator for ROE and the indicator's underlying data. After asking EPA questions of clarification regarding lung cancer risks posed by radon

exposure and about the agency's evaluation of indoor air issues more generally, the reviewers eventually agreed that this indicator should be included in ROE06 with the following minor revisions:

- **Figure 013-1.** Figure 013-1 clearly shows increases in both radon mitigations and new home construction in areas believed to have radon concentrations above EPA's action level. However, quick inspection of the figure would lead a reader to believe that the rate of radon mitigations is actually outpacing the new home construction data, when the opposite is actually true. The reviewers therefore found the figure misleading, but agreed this could be easily corrected by using the same y-axis for both mitigations and new home construction.
- **Other comments.** The reviewers recommended several changes to the text to provide additional contextual information to readers. First, concerned that this indicator's data were derived mostly from multiple assumptions and extrapolations rather than from direct measurements, some reviewers did not find the indicator transparent. They recommended that EPA revise the text to more clearly describe how EPA determined (1) the areas in the country believed to have radon potentials above 4 pCi/L and (2) the annual housing construction estimates for these areas. The reviewers also recommended that the indicator text document more thoroughly key uncertainties and limitations associated with the indicator data. Second, one reviewer thought the indicator would benefit greatly from including a radon potential map (e.g., see http://www.epa.gov/radon/zonemap.html for an example). Third, one reviewer recommended that the indicator text should note, for additional context, the percentage of new homes being constructed in areas with radon potentials above EPA's action level.

2.2.4.2 Blood Cotinine

Reviewed by the Air Group and the Health Group

Air Group

The peer reviewers of the Health Chapter evaluated this indicator in detail. The peer reviewers of the Air Chapter, on the other hand, were asked to comment on limited aspects of the indicator. Overall, these reviewers agreed that the blood cotinine indicator is appropriate, adequate, and useful for evaluating air quality and they agreed that the indicator makes an important contribution to answering the overarching question regarding indoor air quality. The peer reviewers recommended that EPA revise the indicator as follows:

- The indicator text implies that data are available for evaluating temporal variations in blood cotinine levels, but the summary table presents only current data. The reviewers recommended that the graphic used in this indicator better track temporal trends—a recommendation that was also made by the peer reviewers of the Health Chapter.
- The peer reviewers recommended that this indicator include, to the extent the underlying data allows, spatial variations in blood cotinine levels, whether across EPA regions or some other geographic subset of the United States.
- The peer reviewers recommended that the indicator text emphasize that the blood cotinine data are available only for non-smokers, aged 3 years and older. The lack of data for infants is notable, considering this sub-population likely spends the greatest amount of times indoors.

Health Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Important modifications	• Where available, EPA should present additional trend data—in this case, National Health and Nutrition Examination Survey (NHANES) and Morbidity Mortality Weekly Report (MMWR) data. • EPA should acknowledge which bodily fluid is the optimum for measuring cotinine levels, and that the best available data are the blood cotinine levels measured in NHANES.
Other comments	None.

Peer reviewer discussions on blood cotinine levels were relatively brief. All four reviewers agreed that cotinine, a metabolite of nicotine, is an appropriate and useful indicator of exposure to environmental tobacco smoke (ETS). Neither nicotine nor cotinine are generally present in body fluids in the absence of exposure to tobacco smoke—whether through active smoking or involuntary ETS exposures. Specific points made by peer reviewers follow.

- **Data are the best available**. Despite the acknowledged limitations of the data set (e.g., methodology, sample size), reviewers agreed that the indicator is derived from the best available data through NHANES. Though done deliberately, the data set is not representative of the population as a whole. For example, the data set is not overly comprised of Hispanics. The group agreed, however, that the weighting factors applied make this National Center for Health Statistics data adequately representative. In addition, one reviewer noted the importance of understanding and acknowledging what body fluid (e.g., plasma, urine, saliva) is optimum for measuring body burdens of cotinine, citing Idle (1990) and Samet (1992). The half-life of cotinine in blood ranges from 10 to 40 hours, making it a potential indicator of chronic exposures. By contrast, the half-life of cotinine in urine is shorter and would only measure more recent exposures.

- **Trend data needed.** While most reviewers agreed that Table 102_107 provides a good demographic breakdown of the data, they agreed that a discussion or display of temporal trends would strengthen the indicator presentation. Reviewers pointed specifically to trends discussed in MMWR and those being emphasized by Centers for Disease Control and Prevention Administrator Julie Gerberding.

- **Source data also needed**. Reviewers agreed that indicators of ETS exposure (e.g., the number of smokers in the home) should be considered in conjunction with body burden data. See also peer reviewer recommendations for additional national-level indicators presented in Chapter 5 (General Question 2).

References

Idle JR. 1990. Titrating exposure to tobacco smoke using cotinine—a minefield of misunderstandings. J Clin Epidemiol; 43(4):313-7. Review.

Samet JM. 1992. Environmental tobacco smoke. In Lippmann M, ed. Environmental Toxicants. New York: Van Nostrand Reinhold.

2.2.5 RESPONSE TO GENERAL QUESTIONS

2.2.5.1 General Question 1: Relative Value and Importance of Indicators

The peer reviewers discussed the "relative value and importance" of the draft indicators that EPA proposed to include in ROE06. Specifically, they considered whether any indicators stood out as being clearly more appropriate, adequate, or useful in addressing air quality and, conversely, whether any indicators could be removed without a considerable loss of content. The peer reviewers had differences in opinion when answering this question. A summary of the individual reviewers' responses follows:

- If EPA were faced with a decision to remove a large number of indicators from the Air Chapter, one reviewer recommended, EPA should consider removing the emissions indicators because (1) the emissions indicators are based largely on estimates rather than direct measurements and (2) virtually every pollutant with an emissions indicator also has an ambient concentration indicator—a more direct measure of air quality.
- Two reviewers recommended that, if faced with a limited number of indicators, EPA should consider keeping indicators on pollutants that continue to be found at levels of potential health concern (e.g., ozone, PM) and removing indicators on pollutants whose air quality issues have largely been addressed (e.g., lead, nitrogen dioxide). On the other hand, another peer reviewer found it appropriate to include indicators on this latter group of pollutants to have ROE06 demonstrate the effectiveness of air pollution controls.
- Of the pollutant-specific indicators, one peer reviewer found the indicators for groups of compounds, particularly air toxics and VOCs, to be least informative and to offer the least important contributions to answering the overarching questions regarding air quality. This reviewer felt these indicators, because they grouped together emissions of dozens of compounds, masked potentially important pollutant-specific trends.
- Noting that the potential threats from global warming dwarf other environmental concerns, one reviewer felt that the indicators related to greenhouse gases and trends in temperature and precipitation were clearly the most important issues to include of all the indicators. He recommended that EPA include these indicators in ROE06, even if EPA decides to remove some indicators from the Air Chapter.
- The reviewers' pre-meeting comments document further insights on which indicators the individual reviewers felt provided the most important insights to air quality issues. See pages 3-3 and 3-4 of the pre-meeting comment booklet for additional details.

2.2.5.2 General Question 2: Proposed New Indicators

When discussing whether EPA should consider any additional national-level indicators in ROE06, the reviewers focused first on indicators from ROE03 that EPA proposes withdrawing and then on new indicators that the peer reviewers thought EPA should consider.

ROE03 Indicators That EPA Proposes Not Including in ROE06

- **Percent of population living in homes where someone smokes regularly inside the home.** The reviewers unanimously agreed with EPA's decision to not include this indicator in ROE06, though

for reasons other than what EPA provided. The reviewers' conclusion was based on several factors, but mostly on underlying concerns about the reliability of the survey data. As an example of their concern, some reviewers questioned whether parents would reply honestly to questions that asked them about behaviors that might reflect poorly on their parenting skills (i.e., parents who smoke in the home might be inclined to not admit to this behavior to a stranger). The reviewers recommended that EPA consider other metrics for smoking prevalence, such as tracking annual tobacco sales or annual tax revenue from tobacco sales. Though they acknowledged limitations associated with these proposed new indicators (e.g., they do not account for tobacco products purchased outside the United States, trends might not necessarily parallel trends in smoking inside homes), the reviewers agreed that these alternate metrics appear to be more objective than the survey data that EPA previously used for its "environmental tobacco smoke" indicator.

- **Production of ozone-depleting substances.** The peer reviewers unanimously disagreed with EPA's decision to withdraw this indicator from ROE06. While it was noted that production of ozone-depleting substances clearly does not equate with emissions, the reviewers found that this indicator was generally consistent with the indicator definition and met the "indicator criteria" that were provided in the charge to the reviewers. The reviewers agreed that including this indicator in ROE06 would give the readers important global context for understanding the other indicators on stratospheric ozone issues. Consequently, the reviewers recommended that EPA include this indicator in ROE06, provided that the agency is reasonably confident that the underlying data are reliable.
- **Number of people living in counties with ambient air concentrations above the NAAQS.** The reviewers very strongly disagreed with EPA's rationale for not including this indicator in ROE06 (i.e., "because of changing populations and air quality standards…this indicator masks actual trends in the levels of air pollutants"). The peer reviewers viewed this as an important indicator and highly recommended that EPA include this indicator in ROE06 to provide perspective on overall air quality improvements and challenges that remain. The indicator should present fraction of population that lives in counties that exceed NAAQS (thus addressing the potential confounding factor of a growing population), broken down by pollutant, over the entire history of available data. The concerns expressed in EPA's rationale (e.g., shifting population, not all counties being monitored) can be accounted for or otherwise acknowledged in the indicator text.

New National Indicators for EPA's Consideration

- **Nitrogen dioxide concentrations.** Noting that nitrogen dioxide is the only criteria pollutant not addressed in ROE06, the peer reviewers recommended that EPA include an indicator on ambient air concentrations of nitrogen dioxide. The indicator should compare ambient air concentrations to the NAAQS, track the non-attainment trends with time, and discuss the role that nitrogen dioxide plays in atmospheric chemistry.
- **Sea surface temperature and sea level rise.** The peer reviewers unanimously agreed that EPA should include additional indicators relevant to climate change in ROE06. Specifically, they recommended that the report track sea surface temperature and sea level rise, given that a fairly robust data set already exists on these issues. Consistent with their comments on other environmental issues of a global nature, the reviewers recommended that these indicators provide the necessary context such that a reader does not erroneously attribute changes in these metrics solely to greenhouse gas emissions from the United States.
- **Tobacco use.** As stated previously, the peer reviewers recommended that EPA include an indicator that tracks trends in tobacco use to complement the indicator that tracks trends in blood cotinine levels. The reviewers noted that EPA might be able to obtain surrogates for tobacco use from data on

tobacco sales or tobacco tax revenues, possibly by consulting with the U.S. Bureau of Alcohol, Tobacco, and Firearms.

Issues EPA Should Address in the Existing ROE06 Indicators, and Possibly Track as Their Own Separate Indicators in Future ROE Releases

When discussing potential new indicators, the peer reviewers identified several topics that they felt were important to include in ROE06, even if the information available on these topics is not sufficient to support developing a standalone indicator. Specific examples of the reviewers' recommendations follow:

- **Ammonia emissions.** The reviewers agreed that providing information on ammonia emissions is important given that airborne ammonia contributes significantly to formation of secondary particulate matter. The reviewers did not recommend that EPA include a separate ammonia emissions indicator in ROE06, given the current state of the emissions inventory. However, they recommended that EPA revise the text in the PM indicators to explain the key role that ammonia plays in atmospheric chemistry.
- **PM speciation.** The peer reviewers recommended that EPA include additional context on particle speciation in the indicator on ambient air concentrations of PM. Specifically, they noted that sufficient data are probably available to document long-term trends in sulfate content and total carbon content of PM at rural sites. Further, more recent sampling data can be summarized to present current conditions for PM speciation, possibly for the following subsets: sulfate, nitrate, carbon, and crustal. EPA already provides such speciation data in a recent publication titled *The Particle Pollution Report.*
- **Diesel emission trends.** One peer reviewer noted that the Air Chapter currently presents no quantitative information on diesel engine exhaust. Though they noted ongoing debate regarding the toxicity and carcinogenicity of diesel emissions, some peer reviewers felt that ROE06 should include greater contextual information on this potentially important pollutant. One suggestion was for EPA to provide this context in the indicator on "air toxics emissions."
- **UV radiation at the surface.** When discussing the indicator "ozone levels over North America," several peer reviewers recommended that EPA consider tracking UV radiation at the Earth's surface, either instead of or in addition to the data being tracked on stratospheric ozone. Refer to the summary of the peer reviewers' comments on this indicator for more specific suggestions on data sources that EPA can use to track UV radiation at the surface.

2.2.6 PUBLIC COMMENT

On the third and final day of the meeting, the Battery Council International (BCI) made the following oral comment, which is relevant to two of the air indicators.

BCI is a trade association representing 99 percent of U.S. lead battery manufacturers and 98 percent of U.S. lead battery recyclers (i.e., secondary smelters). In its comment, BCI requested that the following two statements concerning ambient lead concentrations be removed from the indicator text, as these statements, according to BCI, are inaccurate and potentially misleading:

- **Indicator: Lead Emissions**

  "The highest air concentrations of lead are usually found in the vicinity of smelters and battery manufacturers."

- **Indicator: Ambient Lead Concentrations**

  "Today, the highest levels of airborne lead are usually found near industrial operations that process materials containing lead, such as smelters and battery manufacturers (EPA, 2003)."

According to BCI, these statements are both correctly attributed to EPA reports. However, neither of the original EPA reports provides data or citations to support these assertions. BCI also believes the statements themselves are inaccurate—or at the very least, taken out of context.

Based on EPA's 2003 TRI inventory, battery manufacturers and secondary smelters together are responsible for only 5 percent of fugitive air emissions of lead (out of the total emitted by the top 100 sources) and 9 percent of point source emissions (also out of the total from the top 100 sources). Further, EPA no longer lists battery manufacturing as a "major source" category for lead. A different EPA report states that major sources of lead emissions include iron and steel production, lead smelters, and combustion of solid waste, coals, and oils (http://www.epa.gov/ttn/atw/nata/pollinf2.html).